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U. S DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY—BULLETIN No. 33, NEW SERIES.

L. O. HOWARD, Chief of Division.

SOME INSECTS INJURIOUS TO VEGETABLE CROPS.

A SERIES OF ARTICLES DEALING WITH INSECTS OF THIS CLASS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY

F. H. CHITTENDEN,

ASSISTANT ENTOMOLOGIST.

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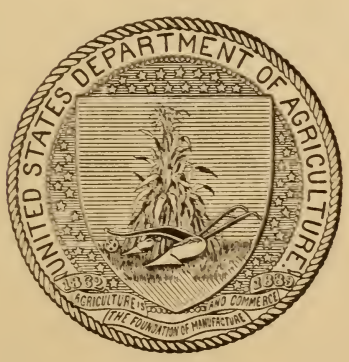
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., April 15, 1902.

Sir: I have the honor to transmit herewith a manuscript containing a large number of accounts of insects injurious to vegetable crops, which have been drawn up, as a result of his investigations, by Mr. F. H. Chittenden, Assistant Entomologist. Mr. Chittenden has been devoting himself assiduously to this work for some years, and has learned a great deal that is valuable to truck farmers and to economic entomologists. I recommend that this manuscript be published as Bulletin No. 33, new series, of this Division.

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

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PREFACE.

The present publication comprises a series of articles and notes brought together in bulletin form in continuation of work begun several years ago, the earlier results of which were published in Bulletin 10 of the present series, in the Yearbooks of this Department for 1896 and 1898, and in several circulars of this office. Bulletin 23 of this series was devoted exclusively to the subject of insects injurious to garden crops and Bulletin 19 mainly to the same subject. This contribution is therefore the third bulletin of the series, and is entitled "Some Insects Injurious to Vegetable Crops."

The various species of noxious insects discussed have, with few exceptions, been destructive during the years 1900 and 1901, but a few came under observation at an earlier date. The work is therefore, to a certain extent, a report on the principal insects which have been injurious and whose ravages have been brought to the attention of this office as affecting the vegetable crops of the country during the past two years. Circumstances beyond the writer's control have prevented the publication of this matter until the present time.

The initial article treats of the potato stalk weevil, which has been very injurious for a number of years but has never received extensive notice in any of the publications of this Department; hence, all available facts concerning it, together with an original illustration, have been brought together. The Northern leaf-footed plant-bug attracted more attention during the last two years than ever before in its history, and its abundance in the vicinity of the District of Columbia enabled a study of its habits and the practical completion of a knowledge of its life history, the results of which are here given.

We have to record the appearance of a new insect enemy of carrot, celery, and some other umbelliferous crops in this country. The insect in question, the carrot rust fly, has been present in Canada since 1885, but was not known as the cause of injury to any crop plants in the United States until the past year, when it occasioned the ruin of 6,000 plants of celery on one farm in New York State. The probabilities are that this species will continue to spread and that it may become an important pest; in fact, the most serious drawback to the cultivation of carrot, parsnip, celery, and other umbelliferous crops. Another insect now holds this distinction. It may be known as the

carrot beetle, as it is to carrot that it does most injury, although parsnip, potato, and other root crops and some other cultivated plants are subject to its depredations. This latter has been quite prominent in recent years, and is therefore deserving of attention.

Although the beet army worm has been destructive since 1899, there are some facts that have been learned in regard to it and its distribution and origin that have not been recorded. Since sugar-beet growing is just now engrossing the attention of legislators and farmers in many sections of the country, it seems appropriate that as complete an article as possible in regard to this, one of the most important enemies of beets, be published. Three species of webworms, one of them more particularly destructive to the sugar beet, the second an introduced and important enemy of cruciferous crops in the South, and the garden webworm, a species of omnivorous habits, have also been the occasion of considerable correspondence.

Several species of insects injurious to cruciferous crops have been under observation. Hitherto no account of the red turnip beetle has appeared in Departmental publications; hence, an account based on injuries in the Northwest is presented. The insect is more particularly destructive in the Dominion of Canada, but also inhabits the United States, and it seems probable that injuries will increase with time. This species is related to the Colorado potato beetle, and at any time an outbreak may be apprehended. The cabbage looper, a common pest throughout the South, and frequently making its appearance as far northward as Long Island in destructive numbers, has, after an almost complete disappearance, returned to the more northern points which it had previously invaded. It is considered in connection with two related species, one of which is new as an enemy of cabbage, and the other known as the celery looper. The cross-striped cabbage worm, or so-called "cabbage Pionea," has a similar distribution to the common cabbage looper, and an account of it is also given. Some shorter notes are presented in regard to some cabbage insects whose habits have not been thoroughly studied, as well as some observations on insects affecting late cabbage and similar crops, the latter article forming the basis for an appeal for clean farming.

A number of insects injurious to beans and other leguminous crops have been prominent during recent years, and four of these, the seed-corn maggot, the bean leaf-roller, the pea moth, and the bean cutworm, are the subjects of articles. The remaining species are treated in an article comprising many subjects. It should be mentioned at this point that the destructive green pea louse continued its ravages during 1900, extending its depredations in the West particularly; but as this species has been given much attention by entomologists in Delaware and Maryland, the writer's notes are withheld. What there was that seemed desirable for early publication was brought out in the

form of a circular. It should be added, however, that injury during 1901 was very light, although some damage was done over small areas.

The season of 1900 was rather remarkable for irruptions of different forms of flea-beetles in various portions of our country, several species doing very considerable damage, in some cases unprecedented.

Assistance has been rendered in the preparation of this bulletin by the writer's associates, which is duly credited in its proper place: but it should be especially mentioned that Mr. F. C. Pratt assisted in the collation of the literature of many of the species treated. Credit is also due to Mr. Th. Pergande for some of the notes, and particularly the rearings made in earlier years, nearly all of those of a later date having been conducted by the writer. Twenty-six of the figures which illustrate this bulletin have been drawn by Miss Lillie Sullivan, under the writer's personal supervision, from selected and fresh material wherever this was obtainable.

F. H. Chittenden.

SOME INSECTS INJURIOUS TO VEGETABLE CROPS.

THE POTATO STALK WEEVIL.

(*Trichobaris trinotata* Say.)

One of the important insect enemies of the potato, and a common species almost everywhere east of the Rocky Mountains and south of New England, is a little gray weevil, whose larva works normally in the stems of wild Solanaceæ, such as horse nettle, ground cherry, and jimson weed, in most fields where these plants are allowed to grow.

The habits of this insect and its manner of attacking potato have been known for half a century, the first instance of injury having been noticed in 1849 near Philadelphia, Pa. Since that time the injuries inflicted by it to potato have attracted considerable attention, periodically and locally, especially during the last decade, and there is reason to believe that it is often present and doing damage, though undetected, in potato fields, where the insect itself has never been seen. Its habit of living within the stem in its larval condition, and the small size of the beetles, together with their habit of dropping from the plants when disturbed, is accountable for injury by the species so often escaping notice. Hence it happens that, although a pest of long standing, the insect is unknown to many potato growers.

During 1900 this species was reported to have done injury near Philadelphia, Pa., and South Holland, Ill., and to have been quite prevalent in Maryland on potato; but injury was without doubt much more extensive than reported. In 1901 the potato crop of Sheridan County, Nebr., was nearly ruined by this insect, and it made its initial appearance in Canada, doing much damage on Pelee Island.

In earlier years more or less damage to the potato crop was committed in other portions of Nebraska, Illinois, Pennsylvania, and Maryland, as well as in Kansas.

DESCRIPTION.

The beetle.—The adult potato stalk weevil is a small ash-gray weevil, or snout-beetle, of the family Curculionidæ. Its real color is black throughout, but its surface is covered with minute gray scales, which give it a nearly uniform gray appearance. The head, however, appears

black, and there are three black impressed spots at the base of the elytra or wing covers—one scutellar and two lateral—from which the insect has derived its Latin name, *trinotata*. The rostrum or snout is robust and rather strongly curved, and the antennæ, like those of other Curculionids, are elbowed and clubbed at the ends. The body is oval and somewhat depressed or flattened above. The male is credited with being generally larger than the female—something rather unusual in insects. The length is about one-sixth of an inch (3 to 4.5^{mm}) and the width less than half that (1.2 to 1.75^{mm}). The beetle is shown in the accompanying illustration (fig. 1, *a*).

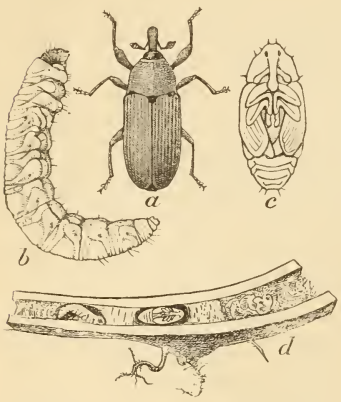


FIG. 1.—*Trichobaris trinotata: a*, beetle; *b*, larva from side; *c*, pupa; *d*, section of potato stalk opened to show larva and pupa *in situ*—*a*, *b*, *c*, five times natural size, *d*, natural size (original.)

The egg is of the usual white color and oval form seen among the Rhynchophora, and, according to the measurements of Faville and Parrott, is about 0.6^{mm} in length and 0.4^{mm} in width.

The larva, or grub, as it appears when first hatched from the egg, does not appear to have been described. It is, however, whitish at this stage, and without feet. When full grown it is remarkably elongate in form, about eight or nine times as long as wide, with small circular pale-brown head, the whole having the appearance shown at *b* (fig. 1). It reaches a length of about two-fifths of an inch (9 to 11^{mm}), and is only moderately curved when in natural position in the stems. Instead of legs these larvæ are provided with feebly defined thoracic leg pads. The color at this, as in the pupal condition, varies from nearly white to rather bright yellow, the color in one instance, in an individual taken from the root stem of *Solanum carolinensis*, being of a decidedly rosy or light pinkish hue.

The pupa looks like that of other weevils, and presents no very noticeable features for description. A ventral view of a pupa is shown at *c* (fig. 1). At *d* a larva and pupa are figured natural size within an opened stalk of potato.

DISTRIBUTION.

The potato stalk weevil is rather generally distributed throughout the Carolinian and Austroriparian regions. Northward the limit of injurious occurrence was reached in Pennsylvania and New Jersey in the East, and in Illinois and Iowa in the West; recently, however, the species has become a pest in Canada. Southward the insect is found to Florida and westward to Texas. A list of localities follows:

Titusville, Little Silver, Freehold, Hopewell, New Brunswick, and Trenton, N. J.; Yorkana, Germantown, Westchester, Pawling, Philadelphia, Allegheny, and Pitts-

ville, Pa.; Newark, Del.; Belair, River View, Cabin John, Marshall Hall, Greenwood, and Baltimore, and Howard, Washington, and Montgomery counties, Md. (Johnson); Rosslyn and Deep Creek, Va.; District of Columbia; North Carolina; South Carolina; Kentucky; Wayne, Cobden, Anna, Carbondale, and Normal, Ill.; Kansas City, Kirkwood, and Cadet, Mo.; Fort Scott, Onega, Wilder, Topeka, Fairmount, Edwardsville, Manhattan, Lawrence, and Connor, Kans., well distributed over the eastern part of the State; Ames, Adel, Davenport and Marcus, and Polk and Boone counties, Iowa; Omaha, Albany, and elsewhere in Nebraska; Cincinnati, Aberdeen, and Gallipolis, Ohio; Detriot, Mich.; Key West and Jacksonville, Fla.; St. Anthony Park, Minn. (Lugger); and Pelee Island, Canada.

Note.—In the southwest this species is replaced by a few others of the same genus and of very similar appearance and habits, but not injurious to the same extent. One of these, *T. mucorea* Lec., is common in Arizona and southern California; and *T. texana* Lec. is a well-known form in Texas, New Mexico, and Colorado.

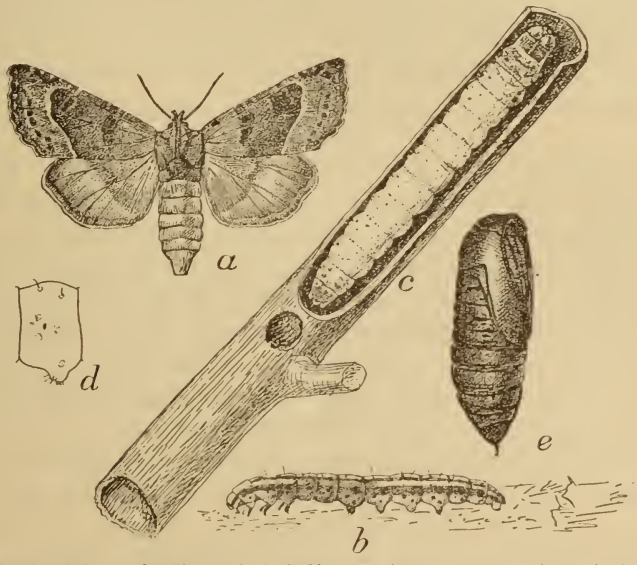


Fig. 2.—*Hydrœcia nitela: a*, female moth; *b*, half-grown larva; *c*, mature larva in injured stalk; *d*, lateral view of abdominal segment of same; *e*, pupa—all somewhat enlarged (original).

T. compacta Casey, according to Cockerell, breeds in *Datura meteloides*, and is common in the Mesilla Valley of New Mexico. It has not been reported to damage potato, perhaps because this vegetable is not much grown in that State. Without doubt all the species of Trichobaris feed on Solanaceæ.

The potato stalk weevil is also known as potato stalk borer, and several other species of insects, the larvæ of moths resembling those which produce cutworms, are sometimes known by the same name. The most common species (in literature) is *Hydrœcia* (*Gortyna*) *nitela*, known as the stalk borer, heart worm, etc. An equally common species in some localities which has practically the same habits is known as *Hydrœcia nebris* Guen.

Even as late as 1897 *Hydrœcia nitela* was referred to as the potato stalk borer, and as doing injury to potatoes in western Maine, damage being due to the larva's boring into the pith of potato stalks, causing them to wilt. It will thus be seen that although the stalk weevil and the stalk borers are entirely different, belonging to different groups, they do injury in a similar manner, and are therefore apt to be confused by those not thoroughly conversant with them. We present a figure of the species

of stalk borer under consideration which will serve as a fair sample of this group. The moth (fig. 2, *a*) is medium brown in color, and marked as shown. The young larva is quite peculiar in having the first three or four abdominal segments suffused in such a manner as to give the insect the appearance of being diseased (see *b*). The larva when mature has more or less the appearance shown at *c*, which, however, will answer almost equally well for other species of the genus. Careful comparative study is necessary in order to establish the differences between these species in their larval stages. An abdominal segment of *Hydræcia nitela* in the larval stage is shown at *d* (fig. 2), while at *e* is shown the female pupa or chrysalis. This insect was reported during 1901, by Mr. F. M. Webster, as having done much injury to wheat and carnations in portions of Ohio. It is to be regretted that several other species are undoubtedly confused with this insect because of their great similarity in the larval stages. The writer, as well as Mr. Pergande, of this office, has reared the moth from the stalks of common pigweed (*Ambrosia trifida*), and there is no doubt of Harris's record of injury by this species to corn. It is credited with having done injury to the stalks of tomato, spinach, cauliflower, eggplant, pepper, dahlia, aster, lily, spiræa, salvia, thistle, milkweed, pigweed, ragweed, smartweed, cocklebur, and castor bean; and to the twigs of blackberry, currant, apple, and peach, as well as to wheat and corn.

RECENT INJURY.

During 1897 Messrs. Kirkpatrick & Son, Connor, Wyandotte County, Kans., sent specimens of the larvæ of this weevil in potato stems, writing July 2 that about one-fourth of the vines at that place were affected, and other fields looked to be over half destroyed. Larvæ were found in vines that looked to be perfectly healthy. To find the insects it was necessary to pull the vine and split it open. September 8 of the same year specimens of this species were received from Mr. George W. Pickering, Wayne, Du Page County, Ill., with the statement that they had been found inside the stalks of potato.

In 1898 Mr. Pickering again sent specimens, July 5 and 30, of larvæ in the stalks. Some presented foliage partly dead, while others which were also inhabited by this insect showed no evidence of infestation. Some hills of potato yielded but few tubers, while others contained a normal yield. It was noted that the infested stalks generally pull easily and break off just below the surface. They appeared rather rusty as a rule, and some had what appeared to be a fungus-like excrescence at the bottom of the stalk.

During 1900 Mr. Samuel Carter, Philadelphia, Pa., sent larvæ within the stalks of potato, with accompanying information, under date of August 15, that this species infested the whole potato crop of that vicinity. He expressed the opinion that the crop was an entire failure, the yield being just about one-eighth of what it should have been.

During 1901 a single report of injury by this potato stalk weevil reached this office. This was made in December by Mr. James Egan, Albany, Nebr., who stated that the potato crop in Sheridan County had been nearly ruined by this insect. Mr. G. W. Pickering, who reported injuries in Illinois in 1897 and 1898, stated that since that

time the insect had done no damage, although he had looked for injury in his vicinity. A gentleman of his acquaintance, who had raised potatoes in one of the potato districts of Pennsylvania, said that this species, as a rule, had little effect on the general crop there. Mr. H. M. Kirkpatrick, who reported injury in 1897, stated that no further damage had been noticed in Wyandotte County, Kans.

From Mr. Edwin Taylor, Edwardsville, Kans., was received information that this species had been present in that vicinity for a good many years, but that it had never injured the potato crop seriously. Writing December 23, 1901, he stated that this insect was less observed that year than usual.

From the above and other sources of information it would seem that this species is unusually periodical, and injuries are generally to be attributed to the growth of potatoes on or in the vicinity of land that has been permitted to run to Solanaceous weeds, nearly all of which furnish food for the potato stalk weevil. A list of these will be furnished later on in the present article.

EARLIER DIVISIONAL RECORDS.

August 1, 1884, vines containing this larva were received from Mr. Richard B. Taylor, Westchester, Pa., with the statement that this borer had destroyed two-thirds of his potato crop (Ann. Rept. Com. Agr. for 1884, p. 411). September 6, 1892, Miss Mary E. Murtfeldt reported the rearing of this curculio from *Solanum carolinense* at Kirkwood, Mo. (Insect Life, Vol. V, p. 135). July 20, 1893, larvæ of this species were received from Mr. H. Still, Deep Creek, Va., found boring in the stems of eggplant, with the statement that the plants were dying by the hundreds daily. August 5, 1895, Mr. W. T. L. Taliaferro, Belair, Md., sent larvæ in stalks of potato. August 26, 1896, we received larvæ and sections of potato stalks killed by this species from Mr. G. C. Brown, Yorkana, Pa., who stated that the insect was new to that locality so far as injuries were concerned. A few other records of injury have been published in the columns of Insect Life and in bulletins of the Division of Entomology.

LITERATURE AND HISTORY OF THE SPECIES.

The potato stalk weevil was first described as *Baridius trinotatus*, in 1831, by Thomas Say (Descr. N. Am. Curculionides, etc., p. 18).

In the year 1849 this insect attracted some attention by its ravages in the vicinity of Germantown, Pa., and Camden, N. J., as related by Miss M. H. Morris, in a communication published in the American Agriculturist of the following year (April, 1850, Vol. IX, pp. 113, 114). The account in question, which is the first that was published concerning this insect, is headed "The Potato Curculio," and is erroneous in some particulars, owing to the fact that the disease known as

potato rot was attributed to this insect, on which assumption it was stated that the ravages of the weevil were traced from Mexico to Maine. The description of the egg and oviposition is wrong, the eggs being described as bright red instead of white in color. During the same year Harris published in the New England Farmer (June 22, 1850, n. s., Vol. II, p. 204) a short account of this species, quoting freely from Miss Morris, entering somewhat into detail to show that it was probably not the cause of the disease of potato. Harris is credited with publishing two more accounts of this species in the next year, but they appeared in popular publications, now inaccessible, which is true of a large proportion of accounts of this insect published by other persons. The writer has references to about 60 communications in regard to this weevil, for the most part short notices of injury and brief general accounts, usually compiled, and containing nothing original or of value otherwise. For this reason mention will be omitted of many of them. In Harris's Insects Injurious to Vegetation a brief popular account is given, based as before on Miss Morris's writings. A short general account was published by Walsh and Riley in 1868 (Am. Ent., Vol. I, p. 22), with illustrations of the insect in three stages, and a similar account by Riley, followed in his First Missouri Report, published in 1869 (pp. 94, 95), with mention of the insect's injurious occurrence in Missouri the previous year.

Several accounts of little consequence followed during succeeding years until 1890. During that year the insect became troublesome in the State of Iowa, and was the subject of study by Prof. C. P. Gillette (Bul. 11, Iowa Agr. Exp. Sta., pp. 490–492). In this account it is stated that this weevil was one of the worst insect pests of the season, and the estimate was made that *half a million of dollars* would probably fall far short of making good the loss that it occasioned to the potato crop in the State of Iowa alone. Two years later the insect was again very injurious in Iowa, as reported by F. A. Sirrine (Bul. 19, Iowa Agr. Exp. Sta., pp. 589–594). Considerable is added to our knowledge of the insect and its wild food plants in this last account. In 1893 it was reported to be injurious in Virginia, New Jersey, Iowa, and Ohio. In 1894 this weevil is mentioned by R. C. Schiedt (Report Penna. State Board of Agriculture, 1894, p. 194) as one of the worst insect pests of that year in Pennsylvania. The same year it attracted attention by its ravages in New Jersey, and was studied by Prof. J. B. Smith, the result taking form in an eight-page article published originally in Bulletin 109, New Jersey Agricultural College Experiment Station (pp. 25–32). This account includes three original illustrations. The following year this weevil was even more widespread in New Jersey than in 1894 (Annual Report N. J. Agr. Col. Exp. Sta. for 1895, p. 390).

During 1896 the potato stalk weevil was quite troublesome in Mary-

land, and was briefly reported by Prof. W. G. Johnson (Bul. 57, Md. Agric. Exp. Station, p. 5). During that year serious damage was done to the potato crop in Kansas, with the result that the insect was given special study by Messrs. Faville and Parrott in a 12-page leaflet (Bul. 82, Kansas State Agric. College Exp. Station). This is a very full account and includes 15 illustrations. A short summary of this article was published as Press Bulletin 19 in December, 1898, and republished in Bulletin 86 (pp. 35–37). Injury was also inflicted the same year in Pennsylvania, complaint having been made at Pawling, in the vicinity of which place infestation was stated to have been evidently quite general (2d An. Rept. Pa. Dept. Agr. for 1896 [1897], pp. 361–363).

In 1897 the potato stalk weevil was reported as doing much injury in Baltimore County, Md. (Bul. 9, n. s., p. 81).

In the Rural New Yorker for August 27, 1898, correspondence is published, with answer by Mr. Slingerland, concerning the occurrence of this species in potato vines at Pittsville, Pa., that year. Owing to its extensive depredations in the potato fields in northeastern Maryland, especially in Harford County, during 1898, an account by Prof. E. Dwight Sanderson was published in the National Stockman and Farmer for December 8, 1898.

During 1899 no reports of injury came to the writer's attention. Moreover, the species was rare wherever sought for in the vicinity of the District of Columbia.

In the Rural New Yorker for August 11, 1900 (p. 544), a short note is published on the occurrence of this species at South Holland, Ill., where it had injured nearly every stem of potatoes, destroying about half the crop. An answer by Mr. Slingerland accompanied this note.

In Dr. Fletcher's report as entomologist and botanist for the experimental farms of Canada (p. 234, 1902), he makes mention of the occurrence of this species for the first time as a Canadian insect. The report is on the authority of Professor Lochhead, and is in brief that many vines were completely destroyed by the potato stalk weevil, present in all stages in September, at Pelee Island. It was stated that the island exported 30,000 bushels of potatoes the previous year, but in 1901 it would have no more than enough for its own consumption and none to spare. This report is followed by a short general account of the insect, with remedies.

NATURE OF INJURY; FOOD PLANTS.

Frequently, more often perhaps than not, injury by this potato pest is attributed to drought or blight. It is more conspicuous in seasons of prolonged drought and most severe on early varieties of potato. The undermining of the stalks of potato by the larvæ causes them to wilt, and the wilting and the dying of the leaves is the first and only

outward manifestation of attack. When the insects are present in the field it is often stated that the plants are "blighted." The diseases of potato, particularly one caused by bacteria, are apt also to be mistaken for the work of the weevil, as in both cases the leaves look as if sunburned, particularly after the vines have been affected for some time. Not infrequently the field will be found to suffer from the combined effects of dry weather, disease, and stalk weevil. To detect the presence of the weevil it is only necessary to cut open the infested stalks, when the insect will be found in some stage in the pith. The weevil's presence is generally shown first in the withering of the lower branches, but in dry, hot weather the whole plant may be affected.

The beetles feed on the leaves of potato and other Solanaceæ, but do no appreciable injury in this stage.

This insect attacks, in addition to potato, nearly all of the Solanaceæ growing wild within its natural range. The list of food plants includes, besides potato, eggplant (*Solanum melongena*), horse nettle (*S. carolinense*), bull nettle (*S. rostratum*), jimson weed (*Datura stramonium*), purple thorn apple (*D. tatula*), ground cherry (*Physalis longifolia*, *philadelphica*, *lanceolata*, *heterophylla*, and *virginiana* var. *ambigua*). According to Faville and Parrott this insect also attacks cocklebur (*Xanthium canadense*). Tobacco and tomato appear exempt.

The presence of a single larva in a potato stalk is not sufficient to injure it to any extent, although it must have a weakening effect, but when many larvæ occur in the same stalk destruction is complete. As many as 5 or 6 individuals may sometimes be found in a potato stalk, and 8 have been observed in the stems of a ground-cherry plant.

LIFE HISTORY.

The beetles have been observed in the vicinity of the District of Columbia as early as May 20 on wild Solanum and Datura, which at that time were only 2 or 3 inches high. It seems probable that the beetles seldom put in an appearance earlier than the middle of May, as the plants are scarcely far enough advanced before that time for food. Pairing was noticed a few days afterwards, and oviposition probably begins normally before the end of the month of May, although farther north it does not commence until June. The female weevil deposits her eggs singly, in small slits or holes about one-twelfth of an inch in length, made in the stalks of the insect's food plants and occasionally in the branches. In about a week or ten days, according to temperature, the larva hatches from the egg and begins to feed by making small channels, which increase in size with the growth of the insect, downward toward the bases of the stalks. After working downward for a distance—usually to the roots—the larva turns about and begins the enlargement of the old channel for a portion of the way upward. The undermining of a stalk by the tunneling of several

larvæ has the effect of impairing the vitality of the plant and causing the leaves to wilt and die. Upon attaining full growth the larva makes a cell of castings and woody fibers in which to transform to pupa and ultimately to adult. The pupal stage varies from eight to eleven days, according to temperature. In the District of Columbia the pupal period was passed in nine days in warm August weather; larvæ have been noted to obtain full growth by the second week of July, and imagos of the new generation have appeared as early as July 24. In more northern localities development is slower, the beetles seldom appearing before August and maturing as late as September. The pupal cells may be constructed in any portion of the stem, but are preferably placed near the roots, where the stalk is firmest and where the beetles will be best protected during their hibernation. All beetles mature by September and hibernation is therefore always as a beetle, and the knowledge of this fact is of value in the control of the species, as will presently be fully explained.

NATURAL ENEMIES.

The potato stalk weevil is subject to the attack of a small dark-colored four-winged parasite fly known as *Siglaphus curculionis* Fitch, a well-known hymenopterous enemy of the plum curculio. A species of chalcis fly was reared at this office from material received in 1896 from Yorkana, Pa. The larvæ, according to Professor Gillette (Insect Life, Vol. III, p. 247), sometimes fall a prey to wireworms. Messrs. Kirkpatrick & Son, previously mentioned in connection with recent injury, sent the larva of *Drasterius amabilis* July 2, 1897, with the statement that several of these wireworms were noticed in the stems of potato that had been infested by the weevil.

REMEDIES.

The potato stalk weevil is not a difficult insect to deal with. About the only remedy that is necessary is to pull up infested vines as soon as they commence to wilt and show evidence of attack, and spread them out so that they will be exposed to the sun and will dry and thus prevent the escape of the insects which they contain. Then all stalks in infested fields should be burned as soon as the crop is off. By thus destroying the weevils the crop of insects for another year will be greatly lessened. In connection with this remedy it is also advisable to keep down all Solanaceous weeds which serve as breeding places for this and other insects and are therefore a standing menace to the culture of potatoes. The time for the destruction of the weeds is in July, after they have attracted the hibernated beetles to them for egg laying, or any time thereafter before the seeds are ripe. For perfect success in this treatment of potato fields, the cooperation of neighboring farmers is essential.

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A liberal use of fertilizers in an infested field will often aid the injured plants to recuperate from insect attack. Unfortunately, injury is not apt to be detected until it is far advanced and the plants begin to die. As soon, therefore, as a plant shows weakness its stalk should be split open to ascertain the cause.

It should be remembered that early potatoes are more subject to injury than later ones, and that the latest varieties are practically exempt from injury.

THE NORTHERN LEAF-FOOTED PLANT-BUG.

(*Leptoglossus oppositus* Say.)

During the season of 1900 this injurious species of plant-bug occurred in great abundance in and about the District of Columbia, and was also reported to be troublesome in Arkansas, Missouri, and Oklahoma. After the publication of the writer's first article on this insect (Bulletin No. 19, n. s., pp. 44–46), it was brought to his attention, first by correspondence and afterwards by observation, that the species of Leptoglossus subsist in all their stages preferably upon the fruit of the plants subject to their attack. The first intimation of this fact came from correspondence with Mr. Henry J. Gerling, St. Charles, Mo., who wrote under date of August 8, 1899, that *L. oppositus* was attacking the fruit of cucumber and the fruit and buds of nest-egg gourd in his vicinity. When first observed the nymphs were about a quarter of an inch long and blood-red in color. After they had pierced the fruit, a waxy secretion exuded from the wounds, such exudation often showing all over the fruit affected.

We have now, as a result of recent investigation, a knowledge of the full life history of the species, which will be presented in detail.

INJURY DURING 1899 AND 1900.

Damage by this plant-bug to gourd and cucumber at St. Charles, Mo., in 1899 has already been mentioned. The fruits or vegetables from which our material was obtained were said to be literally covered with the insects. September 13, 1899, Mr. F. C. Pratt observed attack to the fruit of cucumber at Alexandria, Va. September 25 we received from Mr. Thos. I. Todd, Athens, Ga., specimens of nymphs in different stages, with the report that this insect was injuring the stems of young watermelon.

In 1900, Mr. H. Guibor, House Springs, Mo., sent the young of this species, June 14, mostly in the second stage of the nymph, but with one in the third stage, with the report that they were attacking the fruit of pear. June 25, Mr. John G. Bauranel, Clarksville, Johnson County, Ark., sent specimens with the statement that this plant-bug was preying upon peach and cantaloupe in that locality. Peaches, when ripe, were sometimes found full of imperfect spots, manifested by

a roughening of the skin. When peeled a dark, circular spot caused by the puncture of this insect, which our correspondent likened to the perforation of an awl, could be seen. The insects were present in great numbers on the peaches, quietly sucking the juice. Cantaloupe vines would appear to be perfectly healthy in the morning, and perhaps by noon would be wilted and dying, although roots and stems appeared to be sound. Specimens of this species were observed about the middle of July, and Mr. Otto Heidemann, of this office, states that he saw nymphs of a related species still earlier. July 25, Rev. Fred M. Dickey, Deanewood, D. C., stated that he had recently observed the insects *in copula* on his plums and cherries. July 30 a considerable number of insects were received from the last mentioned locality, some in copulation when received. August 3, Mr. August Busck reported this species very abundant on peach trees in the District of Columbia, most of the specimens captured having been found paired. From the date just mentioned to August 16, Mr. Pratt observed this plant-bug on three occasions at St. Elmo, Va., on stalks of corn where no other crop was growing and on August 27 he found numerous individuals puncturing tomatoes. There were several colonies at work and the majority of the individuals were in the third stage of the nymph. In the first week of September Mr. Pratt noticed that much injury was being done to seed cucumbers, many plants being completely covered with the bugs in their various stages. The following week the same observer found the insect doing some harm to cymlings, near Deanewood.

OCCURRENCE DURING THE SEASON OF 1901.

During 1901 this plant-bug came under frequent observation, more especially by Mr. Pratt at St. Elmo and elsewhere in Virginia. He noticed it on pear, plum, and peach attacking the fruit; he also saw it puncturing corn in milk and tomatoes, and he states that it was as common as in 1900 on cantaloupe and other cucurbits. September 20, Mr. John S. Seibert, Cumberland, Md., sent specimens of the nymph in the last stage, with the information that they were puncturing the fruit of hazel nut, transmitting at the same time nuts showing puncture scars.

This insect is accused of more injury than the mere puncturing of fruits. There is no doubt whatever that in feeding it injects a certain liquid, the same as or similar to that which is secreted by the common squash bug, and that this poisons the plant, causing the fruit to be distorted or checking its growth. It has also been accused of being a transmitter of fungus diseases of pear and other fruit trees. It seems quite probable that this is the case, although further observations are necessary to settle the matter. It was reported too late in the season for careful investigation.

Aside from their preference for fruit as food, the species of Leptoglossus very closely resemble the squash bugs (Anasa) in many of the details of life economy. The eggs are of similar color and net-veined like those of Anasa, but are of different shape and deposited lengthwise instead of in somewhat irregular masses. During the early stages of the nymph the predominating color is red, but in the last stage the close resemblance to Anasa is quite evident. In the length of the stages of the life cycle the two genera do not appear to differ.

THE EGG AND OVIPOSITION.

The eggs are laid in the same manner as those of *L. phyllopus*, in single rows or chains along the stems or leaf-ribs of the plants upon which the insects feed. They evidently differ in coloring from those of *phyllopus*, however, all that have been observed being pale bronze to dark bronze-brown, none of them golden. The eggs are semicylindrical, looking from one end, as shown in figure 3, *c*, and are rather strongly flattened on the lower surface, where attached to a plant. The outline, as seen from above, is short oblong, the eggs being placed so close together end to end that they form what appears to be a stiff, cylindrical rod, of which each egg is a joint or cell. At one end of the egg, covering a little more than half of the distance from that extremity to the other, there is a circular area with a surrounding circle of light color and bearing a transverse curved row of from 4 to 6 elevated points. This circular area comes off like a trapdoor (*e*) for the issuance of the young. Under a microscope of moderately high power the entire surface is seen to be finely reticulate, with rather regular pentagonal and hexagonal areas (*d*). The length of an egg is about 1.4^{mm}, and the width 1–1.15^{mm}, the height being a trifle less. A chain of eggs is shown at *b* (fig. 3), and the sculpture of an egg at *d*. Chains vary in length from those having half a dozen eggs, and measuring about three-eighths of an inch, to others having 26 eggs and measuring 1¼ inches in length.

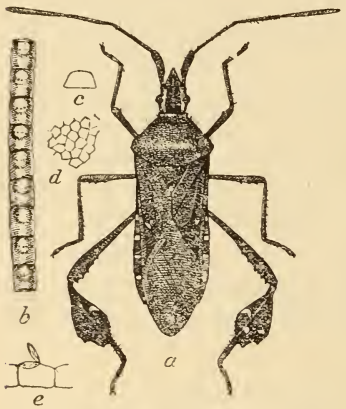


FIG. 3.—*Leptoglossus oppositus: a*, mature bug; *b*, string of eggs; *c*, egg from end; *d*, sculpture of egg; *e*, egg from side, showing opening from which young has escaped—all except *d* about twice natural size (original).

THE NYMPHS.

The nymphs when first transformed have the legs and antennæ rose-colored, the body pale orange-red, the eyes reddish or reddish-brown. The ground colors change, in all except the fifth stage, to brighter

orange or vermilion with dark-brown or black legs and antennæ, while the amount of black on other portions of the body increases with each successive molt.[a]

First stage.—The nymph when first hatched from the egg is pale coral red in color, with long, dark brown or nearly black legs, the proximal half of the antennæ being of the same color and the remainder pale coral, becoming darker soon after hatching. The antennæ and legs are of nearly equal length, about one-fourth longer than the body (with the head). The rostrum, which is kept closely folded under the body when the insect is not feeding, is of the same color as the legs and about three-fourths as long as the body. The posterior portion of the body is sparsely tuberculate, the arrangement being as shown in the accompanying illustration (fig. 4) at *a*. The legs and antennæ are clothed with sparse short black hairs. The tibiæ of the hind legs



FIG. 4.—*Leptoglossus oppositus: a*, nymph of first stage; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, fifth stage—all about two and one-half times natural size (original).

show no evidence of the expansions which appear in later stages. The length of the body when first hatched is about 2.3^{mm}, and the width is about 0.8^{mm}.

Second stage.—With the casting of the first skin, the nymph takes on a more elongated appearance generally, the head, body, antennæ, and legs all being longer and more cylindrical, while the tubercles become more pronounced. The two dorsal abdominal tubercles and the anal extremity become black, and a pair of minute tubercles usually show just behind the pair back of the hind legs. The hind tibiæ shows slight evidence of enlargement. Length when fully matured, 6^{mm}. This stage is illustrated at *b*, fig. 4.

Third stage.—Superficially this stage (fig. 4, *c*) looks but little different from the second. The thorax is longer than the head, the black por-

[a] The differences between the nymphs of this species and of *L. phyllopus* are not nearly so marked as in the two cucurbit-feeding Anasas, *tristis* and *armigera*.

tions of the body are darker and more conspicuous, and the abdominal tubercles more prominent. The antennæ and legs are wider, the latter with the lateral tibial expansions just beginning to show, being now about the same width as the tibia itself, and without teeth. The tubercles are larger, but the dorsal spines are scarcely longer than in the second stage. The haustellum immediately after the molt projects beyond the abdomen to a distance about equal to the length of the head. Length of body just after molt, 6mm.

Fourth stage.—The appearance of this stage is shown at *d*, fig. 4. The antennæ, hind legs, and body are subequal in length, the haustellum a little shorter when first transformed, the width of the body at this time only a little over 2mm, becoming about 3.5mm before the next molt. When "full colored" the body is of about the same appearance as in the third stage, but the red ground color becomes lighter and duller orange before molting, while the black coloring extends farther. The wing pads are bronzy black, occupying more than half the thorax; the tibiæ each marked with a whitish band just below the middle; lateral expansions about two-thirds wider than tarsi, with one more or less feebly marked lateral tooth toward apex. Length when first molted, 9mm.

Fifth stage.—This stage is illustrated at *e*, fig. 4. With the casting of the fourth skin the nymph begins to show the appearance of the mature bug; the antennæ and legs are still shining black, the latter yellowish at the extreme apex, and the tarsi have each a whitish band, as in the preceding stage. The lateral expansions are several times as broad as in the preceding stage, strongly bidentate on the lateral surface, and rather feebly unidentate on the inner portion, which is marked with a medial white spot. The head and body are black, thickly covered with gray pubescence, thickest on the head. The prothorax is narrower at the apex, where it is of about the same width as the base of the head, and broader than the thorax at the base; the sides are nearly straight, with wide orange margin. Just behind the apex of the thorax there is a pair of small, rounded orange tubercles placed rather closely together. Length when first molted, 11mm.

The adult.—A full description of the mature insect has been given by the writer in the article previously mentioned (p. 45), but for the benefit of those who may not have opportunity to refer to that description it may be stated that the parent insect is a large, chocolate-brown heteropterous bug of the same family as the squash bugs, the Coreidæ, from which insects it may be readily distinguished by its more slender form, acutely pointed head, and longer antennæ and legs, but more particularly by the leaf-like expansion of the hind legs (see fig. 3,*a*). The length is 18 to 21mm, and the width across the thorax 5 to 6mm.

DISTRIBUTION.

Leptoglossus oppositus is Austro-riparian in distribution, although it extends about halfway into the Carolinian region and sometimes even farther north, such occurrence, however, in the writer's opinion, being rare and in some cases perhaps accidental. With recorded distribution and the localities furnished during the year, we know that this species occurs in Georgia, Texas, Arkansas, Missouri, Indian Territory, North Carolina, Virginia, Maryland, District of Columbia, Kentucky, Indiana, New York, and New Jersey. In the last-mentioned State it is recorded from Shiloh in September, and it was captured on Staten Island, New York, in October, by Mr. W. T. Davis.

LIFE HISTORY AND HABITS.

The life cycle.—The life history of this plant-bug, as previously intimated, practically duplicates, as regards the length of the different stages, that of our two common species of Anasa, *tristis* and *armigera*. Eggs that were deposited in extremely hot weather in early August produced nymphs in eight days and the first molt of the nymph took place in three days.

The nymphs do not thrive in confinement as well as do those of the species of Anasa, and the working out of the periods of the different stages would, therefore, have been laborious. Assuming the periods to be practically identical, we have the egg stage eight days, the first nymph stage three days, as previously ascertained, and can surmise the second and third nymph stages to be five to seven days each, the fourth five or six days, and the fifth seven or eight days, the minimum period of the entire life cycle probably being about five weeks, and the maximum seldom more than six weeks, except in the case of some of the late broods which occur in the fall.

As with Anasa, there is only a single generation produced each year.

The first appearance of this plant-bug in the neighborhood of the District of Columbia is probably not far from the first day of July, the earliest date when it has been observed. This is two or three weeks later than the appearance of *Anasa tristis*. The first eggs obtained were deposited August 9. Nymphs were first seen August 13; the second stage, August 16.

The first imagos of the new generation developed September 10, and during the next few days many more were seen both in our rearing cages and in the field. The hibernated bugs disappeared a week or two earlier, so that there was no overlapping of generations observable. The second stage of the nymph has been observed during different seasons as late as the middle of September and an individual of the third stage September 23. A belated adult was observed in the second week of November.

Food habits.—It may be well to sum up what is now known of the food and other habits of this species. It is obvious that cucurbits are the favorite food of both adults and nymphs, although the earlier arrivals or hibernated adults are more often found upon fruit trees. The nymphs are most abundant on cucurbits, which naturally is true of adults of the new generation which remain on or in the vicinity of the plants upon which they developed until time for seeking winter quarters. Plums, cherries, peaches, and tomatoes are frequently punctured by the insects in all stages, tomatoes appearing to be preferred in our rearing jars to other food. Green corn is fed upon readily. There is record of occurrence on corn published by Dr. Lintner in the Country Gentleman of October 7, 1886 (p. 753). Of other published records of food habits we have Mr. Ashmead's mention of this species in his enumeration of the insect enemies of cotton; also note of the occurrence of eggs and nymphs on a hedge plant and on Russian apricot. Grape has been recorded as a food by Dr. Lintner (loc. cit.). The natural wild food plant remains to be discovered.

In the report of the Oklahoma Agricultural Experiment Station for 1900–1901 mention is made of this bug as having been received from various parts of Oklahoma, accompanied with the report that it was injuring the fruits of peach and plum by puncturing them and sucking out their juices. The species occasioned considerable alarm there, and farmers were asked to send specimens whenever found, in order that several points in its life history might be determined.

Other habits.—The nymphs, as soon as hatched, group themselves about the chains of eggs and remain there during the day and probably till nightfall. Afterwards they may be found in other locations, and those which have been under observation, both in the field and in confinement, at once selected a place for congregating where they were to be seen throughout the day, the individuals of a colony or those which hatched from a single egg mass always remaining by themselves. In one rearing cage a colony established itself at the base of a squash leaf near the stalk, which appears to be a favorite resting place for this as well as other plant-bugs, including the squash bugs; and another colony formed at the apex of the same leaf, as far as possible from the first colony. Here they remained day after day without mingling. Finally a stray nymph from a third egg mass, and larger than the others, joined the lower colony and remained with them. With the assumption of the third stage, the nymphs kept under observation deserted their original congregating places and collected in another portion of the cage, where they were joined by a newly hatched colony. With later stages it is a matter of common occurrence to find in the field three or four stages in a single group.

A fully matured nymph was observed to shed its last skin October 2,

at 11.30 a. m. At this time it was a light carmine; in the afternoon it had changed to the normal dull black color.

This plant-bug has a similar but much fainter odor than the common squash bug, but in ordinary handling of the creatures, nymphs and adults, it would scarcely be noticed.

NATURAL ENEMIES.

Quite frequently the adults of this plant-bug are noticed with Tachinid eggs on the upper surface of the thorax. During the first week of August a fly was reared from hibernated adults, which proved to be *Trichopoda pennipes* (fig. 5). An adult of the squash bug, *Anasa tristis*, was found September 14 with a nymph of the second stage of this plant-bug affixed to its beak.



FIG. 5.—*Trichopoda pennipes:* adult, fly three times natural size (original).

REMEDIES.

This plant-bug can, in the case of ordinary attack, be controlled by hand-picking or by capturing the insects in inverted umbrellas, bags, or specially prepared nets saturated with kerosene; the best time for their capture being in the early morning or late in the evening, as they are apt to be active, taking wing readily, in the heat of the day.

A certain measure of relief should be obtained by the free use of kerosene emulsion, which will at least kill the younger nymphs.

Some of the remedies in use against the striped cucumber beetle[a] and other insect enemies of cucurbits will assist in the control of this species when it occurs on cucurbits. Among these are the protection of young plants with coverings; the use of repellents, such as land plaster or gypsum, saturated with kerosene or turpentine; the planting of an excess of seed to distribute attack; the stimulation of the growth of the plant by manures or other proper fertilizer; and, lastly, clean cultural practice. If, as soon as the crop is harvested, the vines be gathered and burned, many bugs in their different stages will be destroyed and the crop of insects will be reduced for the ensuing year.

With a knowledge of the natural wild food plant or plants of this species, we might be able to control it in the same manner as suggested for its congener, *L. phyllopus*, which feeds normally upon thistles. This matter is considered on page 48 of Bulletin No. 19, present series.

[a] See Circular No. 31, 2d ser., The Striped Cucumber Beetle, pp. 4–7.

THE CARROT RUST FLY.

(*Psila rosæ* Fab.)

This imported pest, which has been noted as injurious to carrots in Canada since 1885, made its appearance during the season of 1901 in New York, and did considerable injury.

November 14 and 19, 1901, Mr. James Granger, Broadalbin, N. Y., sent specimens of the maggot which proved, on rearing, to be this species, and which he found at work in a celery field during the summer. The larvæ seemed to begin eating into the thick part of the root when the plant was about half grown, stunting it so as to make it worthless for market. About 6,000 plants had been ruined during the season, and traces of the ravages of the maggot were found all over a field containing 60,000 plants.

It is to be regretted that the rearing and subsequent identification of the species was made so late in the season that it was impossible to make any biological observations. The importance of the species as a pest in Europe and its prospective increase and injuriousness in this country are such, however, that it is deemed advisable to present at this time what is known concerning the insect and its life history. All that has been hitherto published on its occurrence in America is from the pen of Dr. James Fletcher, Dominion entomologist of Canada.

Attack on carrots is not difficult of recognition. The leaves of the young plants early in the spring turn reddish, and the roots are found to be blotched with rusty patches, particularly toward their tips. The roots when stored for winter, although not always manifesting any degree of injury on the outer surface, may at times be perforated in all directions by dirty brownish burrows, from which the whitish or yellowish larvæ may be found sometimes projecting.

DESCRIPTIVE.

This species is quite minute, the adult or parent fly measuring only about one-sixth of an inch (4^{mm}) in length, with a wing expanse of a little more than three-tenths of an inch (8^{mm}). The color of the body is dark green, described by some authors as black, and it is rather sparsely clothed with yellow hairs. The head and legs are pale yellow, and the eyes are black. The general appearance of the two sexes is shown at ♂ and ♀, respectively (fig. 6). It will be noted that the male abdomen is rounded at the apex, while that of the female is prolonged into a rather acute point. A more detailed description is given by Curtis.

The larva, about half grown, is figured at *f*, *g*. It is paler than the more mature larva. The full-grown larva resembles rather closely that of the cheese maggot, to which this species is nearly related, but is much darker in color, being rather dark brown, with the segments

well marked, the head, as is usual with related maggots, being minute, while the posterior extremity is truncate. The general appearance is shown at *b*, the spiracles at *c*, and the anal segment at *d*. The length of the mature larva is a little less than three-tenths of an inch (7^{mm}).

The puparium (*e*) is of about the same color as the larva, and the anterior portion is obliquely truncate, recalling the appearance of the anal segment of the Scolytidæ or bark-beetles. The length is nearly one-fifth of an inch (4.5^{mm}).

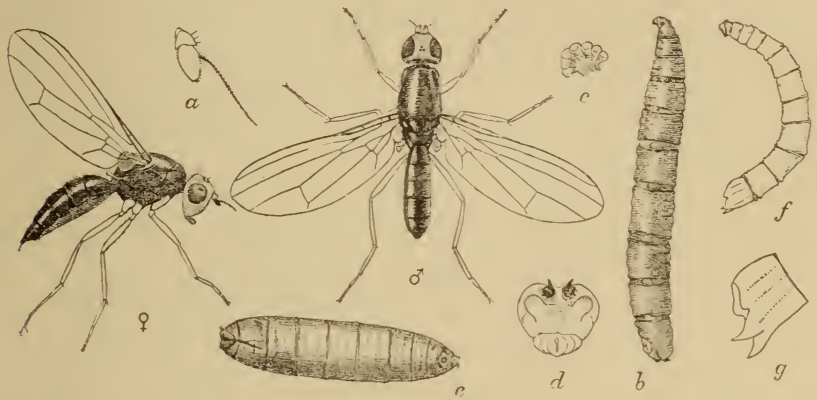


FIG. 6.—*Psila rosæ*: ♂, male fly; ♀, female fly, lateral view; *a*, antenna of male; *b*, full-grown larva, lateral view; *c*, spiracles of same; *d*, anal extremity from the end; *e*, puparium; *f*, young larva; *g*, anal segment from side—flies, young and mature larva, and puparium, eight times natural size; other portions more enlarged (original).

According to Curtis, when the imago issues from the puparium an oval lid on this portion lifts up, permitting the fly to crawl out. The posterior extremity ends in two minute and not prominent dark tubercles.

DISTRIBUTION.

The carrot rust fly is a pest in England and Germany and probably elsewhere on the continent of Europe. It was originally described from Kilia, in Bessarabia. Just when it was first introduced in this country does not appear to be known, but ravages were not apparent until 1885, and until the present year the species seems to have been confined to Canada, although we have in the National Museum a single specimen received from Mrs. A. T. Slosson, labelled Franconia, N. H. New York is apparently, therefore, an unrecorded locality and celery a new food plant. It frequently happens that a species introduced from one country into another, particularly from the Old World into America, assumes new habits and acquires new tastes as regards food. The localities in which the species has been observed in Canada will be mentioned further on.

From the known distribution of the carrot rust fly it would seem probable that this species will not be troublesome far southward, its

establishment in Canada for at least eighteen years indicating its adaptability to a cold climate. It will perhaps not extend farther south than the Upper Austral life area, and for a number of years at least would be most injurious in the more northern portion of that zone and in the Transition. There is little doubt that it will in time spread westward, and may some day become a pest in the celery fields of Michigan.

OCCURRENCE IN CANADA.

The first record of the occurrence of the carrot rust fly in America appears to be that published by Dr. Fletcher, who, as already remarked, has written all that has hitherto been known of the occurrence of this species on this continent. In 1885 carrots purchased in the market at Ottawa were seen to be much mined by small white maggots, which proved by rearing to be the carrot fly (Rpt. Ent., Dept. Agr., Can., 1885, p. 15). In 1886 Dr. Fletcher found young plants of carrot in a garden at Ottawa badly attacked in the spring. The same year a great deal of damage was done, particularly to roots stored for the winter. Mr. F. B. Caulfield, an entomologist of Montreal, reported that in February, 1887, nearly all the carrots that he had seen exposed for sale were more or less attacked. At Nepean, Ontario, early carrots were badly attacked, nearly every root showing signs of the insect's presence, two-thirds of the crop being seriously injured for the market (Rpt. Ent. and Bot., Exp. Farms, Dom. of Can., for 1887 [1888], p. 21).

In 1897 the species was reported as occasioning complaints during the previous ten or twelve years, chiefly in the Province of New Brunswick, but also in Ontario and Quebec. Attack is described as being a serious one, carrots stored for winter use being rendered useless for the table from the discolored burrows of the numerous maggots which sometimes occur in a single root.

In 1895 a correspondent at Rothsay, Kings County, N. B., whose crop had suffered severely from the ravages of this insect, noticed that late sown carrots were less injured than those sown at the ordinary time. Late planting has since been recommended and adopted with considerable success (l. c. for 1897 [1898], pp. 19–198). Specific mention is made of injury at Upper Sackville, Brookville, and Clifton, N. B. In the first locality injury was noticed in 1894 and 1895, at Brookville in 1895, and at Clifton for several years. In the last locality few carrots were raised "of late years on account of this pest." The following year (l. c. for 1898 [1899], pp. 193–194) specific injury to carrots at Noulton and Ste. Marie, Quebec, was noticed.

EUROPEAN LITERATURE OF THE INSECT.

The original description of the carrot rust fly, by Fabricius, appeared in 1792 (Entomologica Systematica, Vol. IV, p. 356) and

under the name of *Musca rosæ*, the specific name evidently being suggested by the capture of the mature fly upon a rose bush, but this is not explained in the text, which reads "*Habitat in Kiliæ floribus.*" In subsequent years the species was redescribed by Fallen, Meigen, Macquart, and Zetterstedt, and in 1834 Bouché (Naturgeschichte der Insekten, pp. 97, 98) gave some account of its habits. In 1837 a popular account was published by Vincent Köllar (Schädliche Insekten, p. 168). Köllar's account is translated in the London edition published in 1840 (pp. 160, 161) the insect being referred to as the "negro fly." The same year John Curtis published, in Farm Insects (pp. 404–407), a still more extensive article with illustrations and descriptions of all stages. Accounts also appeared in subsequent years by Miss E. A. Ormerod (Manual of Injurious Insects and other publications), by Taschenberg, and others. It is probably this fly which Joshua Major mentions in his "Treatise on the Insects most Prevalent on Fruit Trees and Garden Produce," published in London in 1829. On page 183 he states, under the head of carrots, that "the greatest pest to this plant is a small white larva of a small fly (*Pollydismus Complanatus*)". He furnishes the information that moist weather appears to be the most productive of the depredations of this species, stating that under such atmospheric conditions it is not uncommon to see "whole and extensive crops laid waste and rendered useless, by their perforating and defacing the Carrot from one end to the other, which effect gives rise to the common term canker, which gardeners have so much to complain of in this vegetable." On page 199 he also refers to this species as "grub (*Pollydismus Complinatus*)—See on Carrots." He adds that he can suggest nothing for the destruction of the pest since the maggots are so deeply fortified in the plants which they attack that nothing can be applied that will reach them without destroying the plants. He, however, recommends rotation with crops not affected by this species, and avoiding plots that have had carrots the year before.

Zetterstedt quotes Dahlbom (Dipt. Scand., Vol. VI., p. 2403) as having reared this species from larvæ at the roots of turnip (*Brassica rapa*), and rape (*B. napus*).

HABITS OF THE SPECIES.

The life history of the carrot rust fly does not appear to have been worked out. What we know is from the authors that have been quoted. The writer is inclined to believe that in the United States the species will be found to pass the winter usually as a puparium, possibly occasionally also as a larva; but as larvæ work also on carrots in store the flies will develop in winter, as happened in the writer's laboratory, which is kept unusually cool for a working room and still cooler at night during the colder months. Hence we have great irregularity of development, making generalization impossible until we have an

opportunity to make observations in the field. As the larvæ go deep into the ground upon the approach of cold weather it is quite probable that they may be able to survive as such.

In any case, the insect develops rather early in the season. Attack begins with young carrots which turn of a rusty color, and upon examination the roots will be seen to be disfigured with rusty patches, more especially toward the tips. Both flies and maggots are found throughout the warmer months, but the latter desert the roots for pupation in the earth, the last generation probably descending much deeper into the earth than the earlier ones. According to Curtis the summer generations develop in three or four weeks. No one appears to have surmised how many generations are produced. There must be at least two, and probably more. Miss Ormerod states that the fly goes down into the ground for oviposition where she can find a crack or other opening about the roots of the carrot (or other food plant affected), and the maggots when hatched work their way into the roots; when this is quite small they often destroy the lower portion.

NATURAL ENEMIES AND ASSOCIATES.

Curtis found a species of parasitic four-winged fly which he described as *Alysia apii* (Farm Insects, p. 420), and which he presumed was a parasite of this species and connected with its economy.

Polydesmus complanatus Linn. is stated by Curtis to be attracted to the roots, which have been previously perforated by the maggots of this species, sometimes congregating in such vast numbers that he supposed that it was this creature which was reported to have devoured carrots by the acre in Scotland in 1831. This is a European millipede several times reported to be introduced in this country,[a] and it is sometimes accompanied by a centipede known as *Scolopendra electrica*, said to assist in depredations.

[a] Prof. O. F. Cook, who is our best American authority on the Myriapoda, informs the writer that, although this species has been recorded as occurring in the United States, it has not yet been positively recognized on this continent, he having never seen specimens. It seems probable that notwithstanding the fact that this insect must have been brought to this country in potted plants and in earth perhaps thousands of times, it has, for some unknown reason, failed to gain a permanent foothold.

In response to the inquiry of the writer as to whether any of the Myriapoda, better known as thousand-legged worms, millipedes, etc., were capable of original damage to plant tissue, Professor Cook stated that their mouth-parts were not formed either for biting or chewing, and that they were only capable of eroding or scraping diseased tissue, and, to some extent, soft, delicate plants. In this way, however, they can do occasional damage by constantly scraping plant growth like the tubers of potatoes affected with scab and similar diseases, and young, delicate plants that might recover if they were not attacked.

As with other species which feed beneath the surface of the ground, the carrot rust fly is a difficult one to reach with insecticides. Our principal dependence is therefore based upon methods of tillage which will serve to avert attack.

Kerosene emulsion prepared in the proportion of one part to ten of water and sprayed upon the carrots along the rows with a knapsack or other sprayer, or sand, land plaster, or ashes, with which kerosene has been mixed at the rate of half a pint to 3 gallons, sprinkled along the rows, are (with the exception of crude carbolic acid at the rate of half a pint in 5 gallons) about the only applications which have been made with good results. In Canada, according to Dr. Fletcher, one or the other of these applications should be made once a week through June from the time the roots begin to form, and particularly after the rows have been thinned.

Late sowing has also been practiced to great advantage, several persons attesting its value.

Rotation of crops should always be practiced in the case of such species as the present one, and this means the planting of a new bed each year as far as possible from land infested the previous season. Many of those who have complained of injuries have admitted planting carrots on the same ground year after year, and some have testified to the value of rotation.

Destruction of the insects in stored carrots.—Where carrots are stored for winter use in earth this should be treated to destroy the larvæ or puparia which leave the roots to enter the soil for transformation. This may be accomplished in several ways: (1) By burying the earth deeply; (2) by spreading it in thin layers where it will be exposed to the elements; (3) where possible, by throwing it into pools where it will be frozen; or (4) by exposing it to heat or steam in any manner which may be most convenient.

Treatment of the insect in celery beds.—Now that we know that this insect also infests celery, it is obvious that celery should not follow carrots nor carrots celery in rotation. Clean cultivation should be practiced, which means the destruction of all remnants after the celery crop has been harvested, and if the insect is found to destroy celery in store in the same manner as carrots, the earth, after the larvæ have entered it, should be treated in the same manner as described above.

After harvesting, it would be a good plan to give the celery fields a light raking or cultivating of sufficient depth to expose the larvæ or puparia that they may be destroyed by frost; early the following spring, before the flies have time to issue, if the earth be plowed deeply, it will, with little doubt, have the effect of destroying most of the insects; and such as have not been killed by frost and survive

cultivating and raking would be buried so deeply under the ground by the spring plowing that they would not be able to effect their escape.

THE CARROT BEETLE.

(*Ligyrus gibbosus* Dej.)

A very common beetle along the Atlantic coast from Long Island to the Gulf States, and at many points inland, has been reported as the cause of injury to carrots and other root crops, and to some other plants. It first attracted attention from its injury to sunflower and has been given the name of sunflower beetle; but as its record shows it to be the worst insect enemy to carrot and parsnip known in the United States at present, the name of carrot beetle is suggested as more appropriate. It is somewhat of a general feeder, and, as we learn more of its habits, we will doubtless find that it will, on occasion, attack many other plants than those which will be specified.

During the year 1900 it was destructive to corn in Louisiana and Mississippi, and the following year to sunflower in Illinois and to root crops in Indiana.

DESCRIPTION.

The beetle (fig. 7).—From three other species of Ligyrus, *gibbosus* can be distinguished without much difficulty. It is of robust form, like *ruginasus*, the Pacific coast form, and *relictus*, but from both it may be known by its much smaller size. It measures between one-half and five-eighths of an inch in length, and its width is more than half the length. The surface of the elytra is strongly sculptured and coarsely punctate, characters which will distinguish this genus from Lachnosterna. The color varies from reddish brown to nearly black on the dorsal surface. The lower surface is reddish brown, and the legs, which are still brighter colored, are clothed with reddish-yellow hairs. The remaining species, *rugiceps*, is restricted to the South, and is narrower than the others, with a different facies.



FIG. 7.—*Ligyrus gibbosus:* beetle—about twice natural size (original).

The species may further be distinguished from *ruginasus* (with which it agrees in having the thorax impressed in front, and with a small tubercle, and in having the anterior tibiæ tridentate) by the structure of the clypeus which is bidentate or two-toothed, the clypeus in *ruginasus* being unidentate or single-toothed.

The egg is of the usual scarabæid appearance, when recently laid measuring 1.70 mm in length and 1.45 mm in diameter, but when ready to hatch the length is about 2.30 mm and the diameter 2.20 mm. In almost every respect the egg is a counterpart of that of Lachnosterna, which

was described by the writer in Bulletin No. 19 of the present series (p. 75). It is perfectly snow-white with just a perceptible luster when laid, but becomes grayer when near the hatching time. The larva and pupa have never been described, to the writer's knowledge.

DISTRIBUTION.

The list of localities in which *Ligyrus gibbosus* has been observed, and by which it is represented in most cases in the National Museum, includes territory from Long Island to California and Oregon, as well as the Gulf States. It indicates a very wide distribution, but so far as we know at present the species does not occur in the Northern States in the Transition or even in the more northern portions of the Upper Austral life zones. For example, although it is extremely abundant about the city of New York, it does not occur in the central portion of the State. A list of known localities follows:

New York, Staten Island, Long Island, N. Y.; in New Jersey at Trevose, Brigantine, and Highlands, and "throughout the State, but much more common along the shore at light" (Smith); Pennsylvania; Maryland; Cobb's Island, Pennington Gap, Fortress Monroe, and Virginia Beach, Va.; District of Columbia; Keokuk, Iowa; Thomson, Ill.; Purdue and Chesterton, Ind.; Moody, Ark.; Topeka, Riley County, Onaga, and Atchison, Kans.; St. James and Glencoe, Nebr.; Capron and Crescent City, Fla.; Craig, Miss.; San Diego, Plainview, Rock Hill, and Gainesville, Tex.; Salt Lake, Utah; Las Cruces, Albuquerque, Mesilla Valley, and Water Canon, N. Mex.; Yuma and Wilcox, Ariz.; Bayou La Fourche, Mer Rouge, and Ville Platte, La.; Grand Rapids, Wis.; Pueblo, Colo.; Los Angeles, Kern County, and southern California; Hood River, and Dalles, Oreg.

RECENT INJURIOUS AND OTHER UNRECORDED OCCURRENCES.

April 21, 1900, Mr. René L. Derouen, Ville Platte, La., sent specimens of this insect with the report that the species was concerned in the destruction of the corn crop of that vicinity. The beetles were described as cutting the corn just above the roots. The previous year's crop was lost through its depredations, and fear was expressed that the country might suffer very much indeed through the ravages of this pest. Mr. James Lambeth, Craig, Miss., sent specimens, with the information that many of these insects were to be found in a cornfield about an inch deep in the ground.

During 1901 we received in June specimens of the beetle, with information from Prof. W. G. Johnson, associate editor American Agriculturist, that this species was found injuring the roots of sunflower and sweet potato at Thomson, Carroll County, Ill. October 10 we received specimens of beetles eating the roots of celery, carrots, and parsnips, and sent by Mr. F. J. Dickinson, Chesterton, Ind. He stated that the carrot crop appeared to be in good condition, judging from the tops, but when the plants were pulled it was seen that the roots were full of little holes. The beetles appeared to work entirely

under ground, and our correspondent stated that they had ruined the carrot and celery crop that fall. December 5, Mr. Dickinson again wrote in regard to investigations which he had conducted at the writer's request. He succeeded in ascertaining that carrots, at least in that locality, were the chosen food of the beetles, but celery and sweet potatoes were greatly damaged. Of parsnips an occasional root was found that had been eaten into, but not to seriously damage it. Celery was greatly injured by the beetles' gnawing into the roots so that the plants were killed and dwarfed, sometimes so badly that the crop was practically worthless for market. One-half of Mr. Dickinson's sweet potatoes were not marketable on account of the holes made by these beetles.

LITERATURE AND RECORDED INJURIES BY THE SPECIES.

The first account which the writer finds of injuries by the carrot beetle was published in the report of the Commissioner of Agriculture for 1880 (p. 274). About the middle of August of that year specimens were received from St. James, Nebr., where it was reported at the roots of sunflower plants of sickly appearance, from 5 to 25 of the beetles to each plant. They had eaten the bark from the root and scored long grooves in the wood. The larvæ were found in the same situation doing apparently the same work. Later in the fall of the same year a correspondent at Glencoe, Nebr., wrote that this species often nearly exterminated wild sunflower by working at its roots. He had also observed it on cultivated sunflower and dahlia. June 4 of the same year we received from Mr. D. Donaldson, Rock Hill, Bexar County, Tex., a lot of larvæ of this species—which were subsequently reared to adults—with the report that the species was doing much damage to potatoes. Of this lot, one changed to pupa June 14 and others June 16, the beetles issuing June 28 and July 1, respectively. It will thus be seen that the pupal condition for this season required about fourteen or fifteen days. Pupation took place in an oval cavity in the earth formed by the rolling and twisting of the larva. September 16 Mr. J. H. Wayland, Plainview, Tex., sent beetles with the report that they were numerous and doing much damage to shrubs and vegetables of different kinds by working upon their roots, first cutting small roots and afterwards the tops. From 1 to 50 beetles could be found in the ground around the roots of single vegetables, weeds, and small shrubs.

It is plain from the above that injuries must have been quite extensive in the year 1880.

In September, 1889, Mr. F. M. Webster reported the occurrence of this species in destructive numbers on carrot at Purdue, Ind. The carrots were found to be gnawed to the depth of 2 or 3 inches, the cavities thus formed being large and irregular. Injuries con-

tinued during that month and October and up to the 6th of December. (Insect Life, Vol. I, p. 382). During the year 1890 *Ligyrus gibbosus* was reported by Professor Bruner as having been quite destructive to the sugar beet over limited areas toward the western part of the State of Nebraska. It attacked the roots, into which the mature insects gnawed great holes, sometimes entirely embedding themselves. They worked for the most part on old ground and where irrigation was practiced. The work upon the roots extended from the surface to a considerable depth, but was most apparent at about 3 or 4 inches below the surface. In some instances it reached a depth of fully 7 inches (Bul. 23, o. s., p. 17). In 1894 Mr. Webster again reported this species to be destroying sunflowers by eating the roots, the beetles going from hill to hill to continue their depredations. This occurrence took place in Indiana, as before, in St. Joseph County (Insect Life, Vol. VII, p. 206; Ohio Farmer, July 5, 1894, p. 17).

In Bulletin No. 36 of the Mississippi Agricultural Experiment Station, by H. E. Weed (Nov., 1895, pp. 156, 157), an interesting note is published on the occurrence of this species in Mississippi. The injury by the beetles is described as somewhat resembling that of corn billbugs. When a stalk of corn is attacked it presents a wilted appearance, but after a few days of favorable weather it may recover. An excellent illustration of the cause of attack is given, well worth repeating, in Mr. Weed's own language.

> In June of this year many reports were received from Adams County of damage being done by these beetles and we were at a loss as to how to account for the injury. Upon investigation, however, we found the following to be the situation: The beetles were doing damage only in a limited locality, and had done the most damage upon a plantation where some 3,000 head of cattle were pastured last year. The land was not plowed until spring and the corn was planted immediately afterwards. These facts explained the whole matter. The beetles were attracted to the pasture last year by the droppings of the cattle and had deposited their eggs in the grass. The larvæ fed on the roots of the grass last season and changed into mature beetles just before the ground was broken. The corn immediately after was attacked by the beetles, as it was the only vegetation on the land. If the land had not been broken up the beetles would probably have fed on the grass and deposited their eggs as usual.

The substance of this report of injury is repeated in the eighth annual report of the same station (p. 71).

A short general account of this species is given by Messrs. Forbes and Hart in Bulletin No. 60 of the University of Illinois Agricultural Experiment Station (p. 152), which includes an original illustration of the beetle.

SOME DIVISIONAL RECORDS OF ATTACK.

May 9, 1898, Mr. Geo. Davenport, Mer Rouge, La., mailed specimens of this beetle with the report that, although there were few of this insect in corn in that vicinity the previous year, during 1898 they

were very numerous. The beetles went down under the surface of the earth and completely shredded the cornstalk between the surface and the roots. They were described as playing havoc with stands of corn in that region. September 19, of the same year, Mr. B. M. Vaughn, Grand Rapids, Wis., sent specimens of the beetle working in carrot tops and in tubers of dahlia.

During 1899, Mr. J. P. Baker, Moody, Drew County, Ark., sent specimens of beetles, June 3, reporting that they were cutting late plantings of small corn and cotton, as many as 7 or 8 being found on a single plant. Older growth of these crops seemed exempt from attack, evidently owing to their firmer, more woody texture. August 28, Dr. W. H. Ridge, Trevose, Pa., sent specimens of the beetle, stating that they had been destroying great quantities of carrots by boring down and eating the roots off, leaving the ground full of holes.

SUMMARY OF FOOD AND OTHER HABITS.

Our knowledge of the life economy of the carrot beetle is still incomplete. It would appear that in many respects it closely resembles the brown fruit-chafer (*Euphoria inda* Linn.), which has been treated in Bulletin No. 19 (n. s.), pages 67–74. Larval injury has been noted, but there is little doubt that the grubs feed also on humus, manure, and decomposing roots and tap roots of herbaceous plants. The writer has observed larvæ feeding in earth where there was no opportunity for plant attack. Most cases of reported injury have been due to the operations of the beetles, and damage is more pronounced on young plants than on older growth, the latter appearing, in some cases at least, to be exempt from attack, owing to their firmer and more woody texture. Injury may be accomplished both by hibernated individuals in the spring from April to June, according to locality, and by recently transformed specimens in late summer and in autumn.

Like the fruit-chafer again, the species is with little doubt single-brooded. Eggs have been observed by the writer June 8 from which larvæ hatched ten days later. Pupation takes place in an oval cavity in the earth, formed by the rolling and twisting of the grub within, as in the case of allied insects; and the observed pupal period is about fourteen or fifteen days in the warm weather of late June and early July. As these observations were made on material received from Texas, it seems probable that farther north, as, for example, along the coast of New Jersey and Long Island, pupation taking place at a later period requires a longer time. Hibernation, without much doubt, occurs in the adult condition. The favorite food of the beetle is evidently carrot, and after this corn in the Southern States; elsewhere parsnip and celery appear to be chosen. Sweet potato and Irish potato are subject to much damage. Sunflower and dahlia are to be included as food plants, and sugar beet is sometimes injured, as is also cotton.

The writer has found the beetles in numbers about the roots of pigweed (Ambrosia), and other persons have noticed them about weeds. Although the species is rather unusually periodical in injurious attack, it is obviously capable of doing much damage in years when it develops in great numbers.

NATURAL ENEMIES AND METHODS OF CONTROL.

One bird, the chuck-will's-widow, is recorded as having fed on the beetles of *Ligyrus gibbosus* at Gainesville, Tex. (Ins. Life, Vol. II, p. 189).

It is to be regretted that when this insect is present in large numbers in cultivated fields there is little, owing to its manner of working, that can be accomplished in the line of control. About the only thing that can be done is to trap the beetles at night by means of stationary lanterns and pans of water placed below the lanterns, on which is floating a thin scum of kerosene. The lanterns should be stationed at intervals about the field, particularly around the borders. The beetles are strongly attracted to electric lights, but it is not certain that they could be lured from the fields after beginning to feed.

A correspondent reports that by scattering lime through infested fields the beetles have been apparently driven away. It is possible that this or some other similar substance might have a deterrent effect, but it is rather doubtful.

After the crop has been harvested, if the insects continue in numbers in the ground, either in the adult, larval, or pupal stage, it would be profitable to turn in hogs, which soon find and root up such insects from the ground. Chickens also learn to follow the plow after these and similar insects. Crop rotation should also be practiced.

THE BEET ARMY WORM.

(*Laphygma exigua* Hbn.)

Simultaneously with the occurrence of the fall army worm (*Laphygma frugiperda*) in the eastern United States in such unusual and destructive numbers in 1899, as previously reported by the writer (Bul. 29, n. s., pp. 5–46), a similar outbreak of a related species known in American literature as *Laphygma flavimaculata* Harv. occurred in Colorado and New Mexico. The outbreak in Colorado has been mentioned by Prof. C. P. Gillette in several publications, but no comprehensive account of the species has yet been published, and recent studies of literature show that there is such a strong possibility of this species becoming a serious pest eastward that it becomes a practical necessity to bring together all that we know about it. All that has been published in regard to its food habits and ravages in America are from the observations of Professor Gillette, but through the kindness of Dr. H. G. Dyar, of the National Museum, I have been referred to numerous articles on this species going to show that it is widely dis-

tributed and cosmopolitan, although in the United States restricted to an area considerably west of the Mississippi Valley.

Although this insect is obviously of foreign origin, there is probability of its some time migrating in the same manner as did the Colorado potato beetle in the late sixties and early seventies; and it is nearly equally possible that this insect may become as great a foe to the culture of the sugar and garden beet, as well as to other vegetables, as the Colorado beetle has been to the potato, though this may not happen in the near future. It does not confine itself to foliage, but after devouring this eats off the crown of a plant and then the roots.

DESCRIPTIVE.

This species, as might be expected from their relationship, is similar to the fall army worm in all stages, but the resemblance is not close.

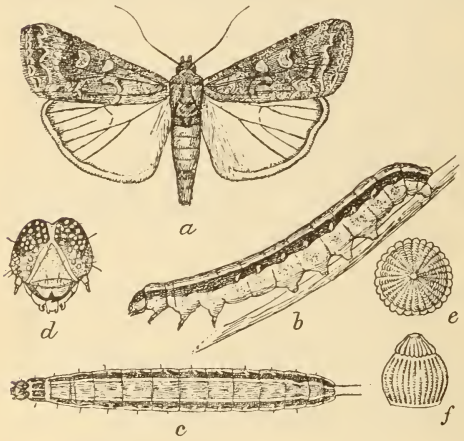


FIG. 8.—*Laphygma exigua: a*, moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, head of larva; *e*, egg, viewed from above; *f*, egg, from side—all enlarged (*a–d*, original; *e*, *f*, after Hofmann).

The moth (fig. 8, *a*) resembles more nearly the plain gray form of *L. frugiperda*, but the fore-wings are broader and paler, the reniform and other spots as well as mottlings are more distinct, but the hind-wings differ very slightly, the veins, particularly the central ones, being a little more distinct. The body is of similar color, but a little more slender. The wing expanse is less than an inch and one-fourth.

A technical description is furnished by Hampson (Fauna of British India, Moths, Vol. II, p. 259), which is quoted herewith:

Pale ochreous brown. Fore-wing with the subbasal, ante-, and post-medial double lines indistinct; the orbicular small and round, pale or ochreous; the reniform usually less prominent, with ochreous or dark center; the submarginal line pale, angled below the costa, and with some slight dark streaks before it at middle; a marginal series of dark specks. Hind-wing semihyaline opalescent white; the veins and outer margin tinged with fuscous.

The eggs are also similar, being ribbed as in the case of most Noctuid moths, but according to the figure and description furnished by Hofmann, they differ by being pyramidal, something unusual in the Noctuidæ. The general appearance of the egg is shown in the illustration at *e* and *f*. It will be noticed that the upper third has the appearance of being surmounted by a cap, and this portion is separated from the lower two-thirds by a white ring.

The larva.—The few specimens of the larva available for description are small or not quite mature, the longest measuring less than an inch and one-fourth, and with much narrower head than that of the fall army worm. The ground color in life is greenish or olivaceous, but this does not show in inflated and alcoholic specimens. The lateral stripe, however, is strongly suggestive of *frugiperda*, although the surface is not marked by the large tubercles present in the latter species. The head is mottled dark brown, with V-mark well indicated; the thoracic plate scarcely different from the abdominal segments save in bearing piliferous warts, while the remainder of the body, with the exception of the head, which is strongly marked with dark brown undulating lines, is faintly clothed, only a few extremely short hairs appearing at intervals. Below the lateral stripe the surface near the spiracles is pinkish. The larva is shown, lateral view, at *b*, and dorsal view at *c*, figure 8; an enlarged section of the first proleg segment of the larva is illustrated in figure 9.



FIG. 9.—*Laphygma exigua:* enlarged section of first proleg segment, dorsal view (original).

Through the kindness of Messrs. Coquillett and Dyar, the following more technical descriptions of the larva are furnished:

The young larva.—The young ones are pale green with a whitish dorsal, subdorsal, and stigmatal line, spiracles white, ringed with black, the head dark brown. Later in life the head becomes green dotted with blackish and the coloring of the body differs considerably in the depth of the coloring even among the different individuals of the same brood and in the same stage of development. In some the ground color is light green, in others the suprastigmal space varies from dark green to almost black.

When first hatched the larvæ spin a web about them and live gregariously for several days, after which they disperse and live separately without any protection. [D. W. Coquillett.]

The mature larva.—Head round, oblique, apex in joint 2; sordid luteous with a few white flecks on the vertices of the lobes; width about 2^{mm}. Body cylindrical, equal, normal, joint 12 scarcely enlarged. Cervical shield smoky or green, cut by three sordid white lines. Green or olivaceous in darker larvæ. A straight subdorsal line a shade paler than the ground color, and a straight broad substigmatal one of the same color but broadly green, filled so as to appear only at the edges, or else in the dark form, blotched in dull red centrally on the segments. Between these lines the lateral space is gray to black, strongly dotted with whitish. Dorsum dotted and lined confusedly in green or blackish, heaviest centrally, defining a narrow obscure pale dorsal line. A bright white speck on tubercle iv, which is at the upper corner of the spiracle. Subventral region pale, mottled in whitish. Feet normal, green, the thoracic ones brown shaded. [H. G. Dyar.]

THE QUESTION OF NOMENCLATURE.

Considering the cosmopolitan distribution of this species, the question of nomenclature becomes important. In Smith's list of Lepidoptera of Boreal America published in 1891 (p. 47) the insect is recorded as *Caradrina flavimaculata* Harv. In its larval as well as adult stage, and in its habits, however, it bears so close a resemblance to the fall army worm (*Laphygma frugiperda*) that it is obvious that the

two species belong in one genus. Sir G. F. Hampson in his Fauna of British India (Moths, Vol. II, p. 259), mentions this species as *Caradrina exigua* Hbn., giving a rather long list of synonyms, of which *Caradrina flavimaculata* Harv. is one. He mentions it in Fauna Hawaiiensis (Vol. I, pt. 2, Macrolepidoptera, p. 153) as *Spodoptera exigua* Hbn., again giving *flavimaculata* Harv. as a synonym. In Staudinger and Rebel's "Catalog der Lepidopteren," published in 1901 (p. 195), the species is referred back to the genus Caradrina, with remarks on synonomy and distribution.

DISTRIBUTION.

There can be no doubt that the beet army worm has been introduced, probably originally on the Pacific coast, and has thence made its way eastward to eastern Colorado and New Mexico. With the possible exception of two army worms, the common army worm and the fall army worm (both of which *may* have been introduced originally many years ago from South and Central America), all of the cutworms which are most destructive and assume the army-worm habit in seasons of unusual abundance are of foreign origin. There are no species positively known to be native which migrate in numbers.

In accepting the opinion of European authorities, Meyrick, Staudinger, and Rebel, as to the identity of this insect with the European *Caradrina* (*Spodoptera*) *exigua* Hbn., we must also adopt the credited distribution which shows it to be truly cosmopolitan. Its range thus includes middle and southern Europe, England and its near-by insular possessions, Borkum, Mauritius, Madeira, Canary Islands, Africa, Asia Minor, Syria, Armenia, Japan, China (?), India, Australia, and the Hawaiian Islands.

Harvey described this species in 1876 from material from Oregon and California (Can. Ent., Vol. VIII, p. 54). So far as the writer is aware, however, it has never occasioned injury on the Pacific coast, which is not a little singular, considering the fact that its favorite food plant, sugar beet, is extensively cultivated in portions of California, and that the insect was doubtless introduced there even before 1876. As to its origin, nothing appears to have been surmised. It is doubtless like so many pests, oriental, and perhaps came from India or Australia by way of Hawaii to California.

From present knowledge of its distribution it is obviously capable of flourishing in both the Lower and Upper Austral life zones, and of doing injury even in the Transition, but it may be that it agrees with its congener, the fall army worm, in being better adapted to the Lower Austral zone.

A single specimen was captured in northern Sonora, Mexico (Biol. Centr.-Amer. Lepidoptera Heterocera, Vol. I, 1900, p. 280).

We have little definite information regarding the region of North America which this species inhabits. The list of localities includes Oregon; Los Angeles, San Bernardino, and other points in California; Fort Collins, Palisades, Delta, Grand Junction, and Montrose, Colo.;

Roswell, Mesilla Valley, and Carlsbad, N. Mex. Both the Colorado and New Mexico localities are east of the Rocky Mountain range, and it appears to be only a matter of time when this species will succeed in invading the great sugar-beet regions of Nebraska; perhaps in time it will also travel farther eastward and become a pest in the Eastern States. It does not seem, however, that there is any immediate danger of general spread as in the case of the Colorado beetle; first, because the insect is a general feeder capable of thriving on plants belonging to several botanical orders, and hence does not need to migrate for food; and second, because the migration of the Colorado beetle is something almost unprecedented in entomological history; third, because according to present evidence the insect is Lower Austral and perhaps Tropical in origin, while the sugar beet grows best in the Upper Austral or Transition zones. From observations of Professor Gillette it is obvious also that this insect, like the fall army worm, although it may invade the Upper Austral area, is not apt to survive severe winters; hence, if it becomes introduced very far northward its ravages will without doubt be sporadic and dependent upon the occurrence of winters sufficiently mild to favor its hibernation.

PROBABLE METHOD OF SPREAD.

As previously surmised, this species has doubtless come to our shores from Australia, India, or somewhere else in the Orient, possibly via the Sandwich Islands, and originally through the "Golden Gate," Los Angeles, or at some intermediate point on the California coast. If it was introduced in the northern portion of California, it drifted southward, as would any other species of semitropical or Lower Austral origin (which zones we conclude must have been the original home of the insect). From southern California its distribution eastward was a matter of easy accomplishment, by short flights of the moths aided by favoring winds through Arizona, possibly extreme northern Mexico, and New Mexico, where few high mountains barred its course, to Colorado, where, according to available data, its further spread appears to have ceased.

In some respects this introduction has been accomplished in what we may surmise was the manner of establishment of certain other injurious insects, examples of which are the potato tuber worm (*Gelechia operculella*) and perhaps the imported cabbage web-worm (*Hellula undalis*), both of which inhabit California. They probably originated in the Orient, and evidently followed a similar course, with this difference, however, that as one feeds in the tubers of potatoes and the other in the heads of cabbage, and both are small species, it is more likely that they were introduced in part by "commercial jumps," which accounts for their being found farther east throughout the South. Both

have spread to the Atlantic seaboard, the former occurring in North Carolina, and the latter in South Carolina. Neither (so far as records show) has invaded Colorado.

ECONOMIC LITERATURE.

The first account that the writer finds of injury by this species in America is entitled "The Sugar-Beet Caterpillar," and was issued as Special Press Bulletin, dated August 19, 1899, of the Colorado Agricultural Experiment Station, C. P. Gillette being the author. Injury in the vicinity of Palestine, Grand Junction, and Fruita is specially mentioned, and some facts on the insect's occurrence are also given, the main portion of the bulletin, however, being devoted to the discussion of remedies. In Press Bulletin No. 3, from the same station and author, a similar account appears.

During the same year also the writer mentioned furnished for Bulletin No. 26, n. s., of the Division of Entomology, an account of this species and its occurrence during 1899, adding as localities infested Delta, Montrose, and Rockyford. From this it appears that although beets were principally devoured, the caterpillars also attacked potato, which in some cases suffered badly, as also small fruit trees where beets were planted in orchards.

In a report of the same writer (12th Report Agl. Expt. Sta. of Colorado for 1899–1900, p. 39) similar injury is cited, the estimate being made that two or three hundred acres of beets were completely ruined in three localities during August. The insect matured in enormous numbers, and was noted to be passing the winter as a moth.

The same writer published in the 22d Annual Report of the State Board of Agriculture of Colorado some additional facts in regard to this insect's life economy (pp. 128–129). This account states that the species disappeared as suddenly in 1900 as it had appeared the preceding season. Since parasitism was not especially noticeable, it was surmised that the insect failed, although for no assignable reason, to properly survive the winter. Three new food plants were added to the list previously furnished, including lambsquarter (Chenopodium), Russian thistle, and saltbush (Atriplex). Mr. E. D. Ball observed that the moths were flying abundantly about the middle of May; caterpillars began hatching the first week in June, and by the middle of that month were abundant. Their ravages were worst on earliest planted beets, late plantings suffering injury only when near weeds or patches of early beets. Thousands of the worms were seen migrating, and they were found to travel two or three feet a minute.

In "The Economic Entomology of the Sugar Beet" (Bul. No. 60, Exp. Sta. Univ. Ill.), by Messrs. Forbes and Hart, an account of this species also appears in which some new facts are given. These

include wild sunflower, Cleome, pea, and leaves of apple as food plants, the data having been derived from observations communicated by Professor Gillette. It is stated that this species evidently hibernates as a moth, and at least two generations of larvæ may be expected each year—the first about June, and the second in August.

A similar account to the last is given by Prof. E. D. Sanderson in "Insects Injurious to Staple Crops," page 262.

An account of this species and its habits, as occurring in Europe, was given in 1893 by Dr. Ernst Hofmann in "Die Raupen der Gross-Schmetterlinge Europas," page 109. This includes a characterization of the genus and descriptions of all stages, with figures of the egg and larva.

The following synonymical list is furnished by Hampson (Fauna British India, Moths, Vol. II, 1894, p. 259):

Caradrina orbicularis, Wlk. Cat. x, p. 294.
Caradrina venosa, Butl. Ent. Mo. Mag. xvii, p. 7; C. & S., no. 2115.
Spodoptera cilium, Guen. Noct. i, p. 156; C. & S., no. 2117.
Spodoptera insulsa, Wlk. Cat. xxxii, p. 648.
Spodoptera erica, Butl. P. Z. S., 1880, p. 675.
Laphygma cycloides, Guen. Noct. i, p. 157.
Laphygma macra, Guen. Noct. i, p. 157.
Laphygma? caradrinoides, Wlk. Cat. ix, p. 190.
Caradrina flavimaculata, Harv., Grote, New Check-list, p. 30.
Caradrina insignata, C. & S., no. 2112 (*nec* Wlk.).

Huebner's description appeared some time in the early part of the century in Sammlung europäischer Schmetterlinge, Noct. fig. 362. This publication, however, is not available at the present writing, and the exact date of its issuance can not be determined.

RECENT DIVISIONAL REPORTS OF INJURY.

The first intimation that the writer had of the occurrence of the beet army worm in injurious numbers in this country was received through Prof. J. B. Smith, who wrote in February, 1900, that it had been reported by Professor Gillette as destructive in Colorado during the season of 1899. In response to inquiry, Professor Gillette wrote that there had been a considerable outbreak in Colorado during that summer, and prior to that season only three specimens of the insect had been present in the college collection. The caterpillars were very abundant during August at Grand Junction, Palisades, Delta, and Montrose, and specimens of the insect were also received from Rockyford, where they were reported to depredate on beets. Hundreds of acres of beets were not harvested because of the ravages of this species in the region about Grand Junction.

It was noticed that but little destruction of the last brood by insect enemies was observed, and that the moths appeared during the latter part of August and September in prodigious numbers.

"The moths spend the winter evidently in hibernation," since examination of the ovaries of many of the females appearing in the fall failed to show the ova developed in any case.

During the same season Mr. Vernon Bailey, of the Biological Survey of this Department, observed this beet army worm in large numbers on the foliage of young sugar beets in a field near Eddy, now Carlsbad, N. Mex. According to Mr. Bailey's notes (which were accompanied by specimens), the first occurrence was noted June 19, 1899, and the larvæ were doing much damage to sugar beets in the Pecos Valley near Roswell and Eddy. Extensive areas, including in some cases entire fields, were destroyed, necessitating replanting and sometimes the abandoning of the crops. The crop of that region was generally injured. Mr. Bailey informs the writer that a sugar-beet factory started at Eddy has since been put out of operation, and sugar beets have been raised there since only to a limited extent for feeding stock. The cultivated portion of the valley lies mainly in the Lower Sonoran life zone, but is so near the Upper Sonoran zone as to have a mixture of the species from the latter.

During the summer of 1901 Mr. A. N. Caudell, of this office, spent some time in the collection of insects in portions of Colorado, and gathered some material found injurious to cultivated crops. Among this was the beet army worm, all stages of which were found on sugar beet at Palisades, Mesa County, and at Delta. At the latter place larvæ were captured also on table beet, although they did not occur on this variety of the plant in injurious numbers.

In a letter dated February 4, 1902, Prof. T. D. A. Cockerell furnishes the writer the information that this species, which he listed on page 35 of Bulletin No. 24 of the New Mexico Agricultural Experiment Station, as occurring in Mesilla Valley, New Mexico, had been reared by him from the larva depredating on cultivated onion.

EARLIER RECORDS.

The first record that appears to have been made, unpublished hitherto, however, was by Mr. D. W. Coquillett, when employed as field agent of this Division in California. May 25, 1882, he found the larva at Anaheim, Cal. The following day the larvæ spun their cocoons, and moths began issuing on the 14th of the following month. At the latter date more larvæ were found, of all sizes, feeding on corn, *Chenopodium album* and *Amaranthus retroflexus*. Some of the largest were placed in rearing cages, and June 22 crept beneath the litter in the cages and spun very thin cocoons. The moths issued the second week in July. An extended search for larvæ was made in the field July 8, but without success. November 5 still other larvæ were found in the above-mentioned locality feeding on a species of

mallow (*Malva borealis*). Some of these began spinning their cocoons three days later, and by November 14 all had spun up. Two produced moths December 12. October 24, 1886, a larva was found at Los Angeles, Cal., feeding on *Nicotiana glauca*. This produced a moth November 21. Two years later, February 18, Mr. Coquillett captured a moth much worn.

The above notes are of particular interest as showing new food plants and as verifying Professor Gillette's observations on the hibernation of the species in the adult condition.

We would naturally expect a somewhat different life history as regards dates of appearance and disappearance in localities in southern California, so different from that of Colorado. According to Mr. Coquillett's observations, moths were rare in April, but became abundant the latter part of May and during June. Adopting the hypothesis, if it can be called such, that hibernation takes place as moth, some moths must appear in early April in order to produce mature larvæ as early as May 25. With the somewhat incomplete notes on actual field observations, it would appear that this species, like many other Noctuids, such as common species of cutworms, has a spring brood and a late autumn brood, but differs from most cutworms in the stage of hibernation. Between the first and second generations there is evidently a very long season of æstivation or complete quietude passed under the ground when the larva does not feed.

SUMMARY OF FOOD PLANTS.

As with other larvæ that frequently or occasionally migrate in numbers, the beet army worm is liable to attack most forms of vegetation in its line of march. Sugar beet appears to be the favorite host plant, but table beets are also relished, and the larvæ feed quite as well on lambsquarters (Chenopodium) and pigweed (Amaranthus). They also attack saltbush or saltweed (Atriplex), all plants rather closely related to beets. When numerous they affect corn, potato, pea, onion, wild sunflower, the leaves of apple, mallow (Malva), *Nicotiana glauca*, Cleome, and plantain (Meyrick). They are also said to feed on wild grasses.

NATURAL ENEMIES.

A single enemy appears to be recorded for the beet army worm, a Tachina fly, reared at this office May 29, 1897, from a caterpillar received May 17 of that year from Mr. S. A. Pease, San Bernardino, Cal. This is *Frontina archippivora* Will., a rather common species on the Pacific coast, although it occurs eastward also. It is a parasite of *Agrotis ypsilon*, a destructive cutworm, as well as of other moths and some butterflies (Tech. Ser., No. 7, Div. Ent., p. 15).

METHODS OF CONTROL.

Several remedies were tried in Colorado during the year of greatest infestation there with satisfactory results. These included Paris green and kerosene emulsion. Both killed the insects, checking their numbers for the following year. Paris green was applied in the form of a spray and dry, mixed with flour. Used with flour it cost about 80 cents an acre. Two sprayings with the liquid preparation were found to be most effectual.

When this species occurs in fairly injurious numbers the remedies that have been specified should be sufficient. When it is unduly abundant, however, army-worm remedies should be applied. The latter form of remedies is discussed in Bulletin No. 29 (n. s.), a copy of which will be furnished to anyone desiring it.

NOTES ON WEBWORMS.

During the last two years three species of webworms that occur in gardens and do more or less injury to various crops have been reported as the cause of damage in various parts of our country. These are the garden webworm, beet webworm, and imported cabbage worm, each of which will be considered under a separate heading.

THE GARDEN WEBWORM.

(*Loxostege similalis* Guen.)[a]

The reported injurious abundance of the garden webworm during the year 1900 in localities in three different States indicate that this species was somewhat generally destructive in that region that year. It is rather singular that, although the insect is widely distributed, real injuries by it appear to be confined to the States bordering the Mississippi River in the South. Some of the notes given show that it has even a longer list of food plants than have yet been credited to it.

May 14, 1900, Mr. J. D. Mitchell, Victoria, Tex., reported this webworm as abundant in his vicinity, where it was known locally as the grass worm, a name which it shares with the better-known grass worm or fall army worm (*Laphygma frugiperda*). Its favorite food in that

[a] In early works this species has been generally referred to *Eurycreon rantalis* Guen., and now to *Phlyctænodes similalis* Gn. The following synonymy is credited by Sir G. F. Hampson (Pr. Zool. Soc. Lond., p. 210, 1899), in addition to eight names bestowed by Walker:

Phlyctænodes similalis Guen. Delt. & Pyr., p. 405.

Nymphula rantalis Guen. Delt. & Pyr., 405.

Botys posticata Grote and Rob. Trans. Am. Ent. Soc., 1, p. 22, pl. 2, f. 25.

Eurycreon communis Grote. Can. Ent., ix, p. 105.

Eurycreon occidentalis Pack. Ann. N. Y. Lyc., x, p. 260.

The list of Walker's names includes: *Ebulea murcialis*, *Botys licealis*, *B. siriusalis*, *Scopula nestusalis*, *crinisalis*, *thoónalis*, and *diotimealis*, and *Nephopteryx intractella*.

locality, according to our correspondent's observations, appears to consist in the finer and softer forms of grasses, such as buffalo, crab, and joint grasses. In some seasons the caterpillars did great damage in patches. In ordinary years they were found here, as elsewhere, "worming" the so-called "careless weed" (*Amaranthus* spp.), particularly in cotton fields. When other foods failed the larvæ attacked young cotton, but if the field was kept clean and well cultivated it was not injured. June 13 Mr. W. J. Patton, Springdale, Washington County, Ark., gave information that the moths were found everywhere in field and orchard in prodigious numbers, and that the greatest apprehension was felt lest the larvæ which would develop from the eggs deposited by the moths would do great damage. July 24 Prof. H. A. Morgan, Baton Rouge, La., wrote that this webworm was a pest upon cotton and alfalfa in the northern portion of his State.

In the three instances of injury that have been cited communications were accompanied by specimens.

The larva at maturity is somewhat variable in color, but such individuals as have come under the writer's notice from different sources are usually dull pale green above and dull greenish yellow on the lower surface. The dorsal surface is strongly marked with large shining jet-black piliferous spots, more or less distinctly relieved by a paler border, and there is a median double pale line in well-marked individuals and a lateral single whitish line, while below this line the piliferous spots are lighter. The head is dull gray, mottled with brown. The hairs proceeding from the tubercles are mostly single and black; some are in pairs, and those of the dorsal surface are surrounded by a small area of white, and of the ventral surface by a much larger area. Just before transformation larvæ become paler yellow. The length when full grown is a little less than an inch (21–23^{mm}).

ORIGIN AND DISTRIBUTION OF THE BEET WEBWORM.

(*Loxostege sticticalis* Linn.)[a]

For some reason writers on this species, which is shown in fig. 10, appear to have overlooked the fact that it is not native, but introduced from abroad, presumably on the Pacific coast, whence it has found its way eastward to Colorado and Nebraska. From specimens in

[a] The following synonymy has been indicated by Hampson (Proc. Zool. Soc. Lond., 1899, p. 211):

Phlyctænodes sticticalis Linn. Faun. Suec., 1354.

Pyralis fuscalis Hübn. Pyr. f., 45.

Pyralis tetragonalis Haw. Lep. Brit., p. 385.

Pyralis lupulina Cl. Icon., pl. ix, f. 4.

The species is mentioned by Kaltenbach as *Botys sticticalis* Linn., and Meyrick (Handb. Brit. Lep., 1895, p. 418) preserves the better-known name of *Loxostege sticticalis* Linn.

the National Museum it seems that the insect was collected at Palmer, Utah, in July, 1869, which is evidence that it must have been introduced many years earlier. In 1873 it was found in central Missouri. It has been taken by Messrs. Dyar and Caudell in Denver, Salida, and Sedalia, Colo., by Cockerell on the top of the range between Sapola and Pecos rivers in New Mexico at about 11,000 feet elevation. It is also recorded from Winnipeg, Manitoba, as well as from several localities in Nebraska, Kansas, and Michigan. It does not appear to have been observed in Illinois, although search has doubtless been made for it on sugar beets cultivated in that State. Dr. Dyar, in a note to the writer, generalizes that the species is rather common throughout the Rocky Mountain range.

Meyrick records this species as inhabiting England, Ireland, western and central Europe, and northern Asia, as well as North America, and mentions its occurrence on the upper side of the leaves of *Artemisia vulgaris* and *campestris*. Kaltenbach also records Artemisia as a food plant.

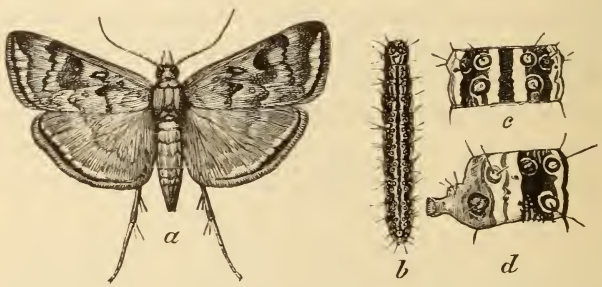


FIG. 10.—*Loxostege sticticalis: a*, moth, twice natural size; *b*, larva, less enlarged; *c*, upper surface of first proleg segment of larva; *d*, side view of same, *c*, *d*, more enlarged (reengraved after Insect Life).

There seems no reasonable doubt that we have another case of introduction from Asia into the Pacific States of this country, analogous to that of the beet army worm treated in preceding pages. There is this difference, however, that the present species was introduced many years earlier, has a much wider range, and is capable of sustaining life in several zones, from the Lower Austral, perhaps to the Transition. There is no doubt about the establishment of the species in the Colorado localities, but larvæ do not appear to have been observed in the localities mentioned in New Mexico and Manitoba, which are obviously transitional.

THE IMPORTED CABBAGE WEBWORM.

(*Hellula undalis* Fab.)

Up to November 19, 1900, only one complaint of injury effected by the imported cabbage webworm reached this office. It was, however, reported from a new locality in Georgia by Mr. H. Walter McWilliams,

of Griffin, in a letter dated November 15. He stated that this insect had been very destructive during the season. December 1 he sent specimens, and stated that the insect had cost some of his neighbors several hundred dollars, the larvae having simply eaten the buds from all the ruta-bagas and turnips in the settlement, causing the plants to rot and fail to develop roots. May 7, 1900, Mr. J. H. Heard, Montreal, Ga., wrote that this webworm had made its appearance in his vicinity the previous year.

During 1901 Mr. W. M. Scott, State entomologist, Atlanta, Ga., wrote, July 1, that this species was still prevalent in southern Georgia. During 1900 it appeared in injurious numbers at Augusta, Tifton, Albany, Marshallville, Fort Valley, and Meansville, its occurrence in these localities indicating that it was generally distributed throughout the southern part of that State. A Mr. Long, Leesburg, Ga., had informed Mr. Scott that only the week before writing this webworm had practically precluded the possibility of growing late cruciferous vegetables in that section. In 1900 his crop of late turnips was entirely destroyed by this pest as if by fire. October 28 Mr. H. Walter McWilliams reported this species still present at Griffin, Ga., and likely to remain. It devoured cabbage, ruta-baga, turnip, rape, etc. He had tried several mixtures, but without any noticeable good effects. November 9 Miss Blanche Dix sent larvae of this species from Beech Island, S. C. In an earlier letter she referred to having observed this species present on cruciferous crop plants in that locality.

THE RED TURNIP BEETLE.

(*Entomoscelis adonidis* Pall.)

In a letter dated March 9, 1900, Mr. Percy B. Gregson, Waghorn, Alberta, Northwest Territory, wrote that this species was very abundant in several districts in his vicinity, and that even so late as October, 1899, he had letters from farmers complaining of it. June 29 our correspondent sent specimens of the beetles noticed *in coitu* at the time of gathering them, and when they reached this office July 9, eggs were found in the soil in which they had been packed. In 1901 this insect was also troublesome in the same region.

This species is occasionally troublesome through its ravages on turnip, cabbage, and other crucifers in the Northwest. Up to date, however, it has attracted little or no attention in the United States, receiving frequent mention, however, in different Canadian publications, chiefly by Dr. James Fletcher, in his annual reports as Entomologist and Botanist of the Dominion of Canada.

DESCRIPTIVE.

The beetle.—The adult of this insect, as its common name would indicate, is red; at first glance nearly scarlet. The under surface of the

body is black, as are also the eyes, legs, and antennæ. The dorsal surface is mostly red, with the middle portion of the thorax black. The elytra are ornamented with three stripes, a rather narrow sutural one, and a shorter black stripe on each side, about midway between the suture and the margins. (See fig. 11.) The punctation of the elytra is dense and rather fine. The form of the body is elongate oval. The length is about one-fourth inch or longer. The species belongs to a genus represented by several forms in Europe, but it is the sole representative of its genus in this country. Zoologically, Entomoscelis is placed near Chrysomela; hence this insect is a relative of the Colorado potato beetle (*Chrysomela* [*Doryphora*] *decemlineata*). It is characterized by having a long metasternum and closed front coxal cavities, having the tibiæ gradually but not strongly dilated at the apices, the outer face deeply concave, the distal edge obtusely angulated, and the claws simple.



FIG. 11.—*Entomoscelis adonidis*—much enlarged (original).

The egg is elliptical in form, twice or a little more than twice as long as wide at its greatest diameter, deep blood-red in color, and finely hexagonally granulated, the areas being just discernable with a one-fourth-inch hand lens. Length, 1.50 to 1.60^{mm}; width, 0.75 to 0.80^{mm}.

The larva has been fully described by Doctor Fletcher and others, who will be quoted. When first hatched it is orange, with black spots, but turns black in twenty-four hours. It is then wedge-shaped, and measures about 2^{mm} in length. It undergoes two molts. In the second stage it measures 3.25^{mm} when not extended. The body is now slug-shaped, flattened below and rounded above; not narrowed at the thorax, as is the case with the larva of the Colorado potato beetle. In the third stage the larva measures about 5^{mm}, and does not differ materially from the second stage. When fully mature the larva reaches a length of about one-half an inch (12^{mm}).

The pupa is bright orange in color, the wing, antennal, and leg cases, honey-yellow, the first mentioned bearing each three longitudinal striæ.

DISTRIBUTION.

This species is common to North America, Europe, and Asia, and evidently belongs to what is known as the circumpolar fauna; in other words, it is not of recent introduction, but is native to the boreal regions of both the old and new world.

According to Doctor Hamilton (Trans. Am. Ent. Soc., Vol. XXI, 1894, p. 397), it is to be found everywhere through the Rocky Mountains at 8,000 to 11,000 feet elevation (Bowditch). A more exact list of localities includes Montana, Hesterburg's Lane, Colorado (Cockerell); British Columbia; Fort Simpson and Mackenzie River, Alaska (Leconte); the Hudson Bay region, Minnedosa, Elkhorn, Brandon, and

Lorlie, Manitoba; Alberta, Saskatoon, Yorkton, Grenfell, Pheasant Forks, and Regina, Northwest Territory. According to Fletcher, it is rare toward the eastern and western limits of its range. The foreign distribution comprises southern Europe, including France, Austria, Germany, Roumania, Western and Eastern Siberia to Turkestan.

DIVISIONAL RECORDS.

Writing December 1, 1900, Mr. Gregson stated that immediately after the receipt of the writer's letter, dated August 22, he paid a visit to the farm where Swede turnips were being injured by this species. Many of the beetles were still feeding, and he succeeded in securing a number of eggs, as many of the individuals captured were in copulation. About this time the weather turned very cold, snow falling to a depth of many inches, with an extremely low temperature for September, the result being that none of the eggs hatched. The eggs obtained by the writer at Washington during the extremely hot weather also failed to hatch.

These observations are in uniformity with those made by M. Lesne in Roumania and Dr. Fletcher and his correspondents in the Northwest Territory of Canada, conclusively showing that eggs do not hatch until the following spring.

According to Mr. Gregson's observations, the eggs are never found on growing foliage. They are deposited invariably under dead leaves and in similar rubbish on the ground, or under a small clod of earth or other shelter about the roots of turnip or other food plant. The larvæ appear to attack plants chiefly at night.

Writing August 15, 1900, our correspondent stated that he had recently left a district very badly infested with this species. One of the farmers whose crop was inspected had just planted out his third lot of young cabbages, and had also resown his turnips three times, each crop having been destroyed by this pest, larvæ and beetles of which were at work.

September 6, 1901, Mr. Gregson stated that he had kept careful watch for this species during the year, and had made special visits to farms where in ordinary years he had always reckoned on finding plenty of the beetles. He had also received letters from different farmers who had been on the lookout for this species, but the insect had apparently entirely disappeared, at least temporarily, from that portion of Alberta, Northwest Territory. It is probable that atmospheric conditions have been responsible for the insect's nonappearance during the year. In that vicinity an unprecedentedly wet year was experienced in 1900, and a still wetter spring and summer followed in 1901. Assuming that this has been prejudicial to the beetles, it is quite evident that this species is largely dependent upon the weather for its multiplication, and that it prefers dry weather. This statement is borne out by M. Lesne, who writes that "droughts favor its multiplication while cold and rainy weather greatly retard it." Had it appeared in considerable numbers, Mr. Gregson writes he would certainly have heard of it.

Entomoscelis adonidis was given its specific name by Pallas in 1771 (Reisen durch versch. Prov. des Russ. Reiches, etc., Vols. I, 2, p. 463), the description appearing under the genus Chrysomela. It has also been placed in the genus Phædon (Kirby, Fauna Bor. Am.) and was described by Fabricius as *trilineata* (Gen. Ins. Mant., 1777, p. 219). Künstler, Köppen, Weise, Tömösvary, Lesne, and other European writers have furnished descriptions of the larva. (See Rupertsberger Biol. Lit. Käfer Europas von 1880 an. etc., 1894, p. 259.)

Rape (*Brassica napus*), *Cochlearia draba*, butter-bur (*Petasites petasites* [*officinalis*], and *Adonis autumnalis* have been recorded as food plants by European authors, as also thistle and barley (Korn).

Of recent publications the reader is referred to Erichson's Naturgeschichte der Insecten Deutchlands (Vol. VI, p. 310–312) and Lesne in the Annales de la Société Entomologiques de France for 1890 (Vol. VI, pp. 177–179, figs. 1–9), for technical descriptions and bibliography, as also to Dr. Fletcher's works, which will presently be mentioned. M. Lesne's article is accompanied by an illustration of the larva.

What appears to be the first instance of attack by the red turnip beetle on cultivated plants in America was recorded by Dr. Fletcher in his report as entomologist and botanist for the year 1887 (1888, p. 19). He states briefly that he collected this species on turnips at Regina, Northwest Territory, in August, 1885. The beetles were noticed to be sluggish in their habits, like the Colorado potato beetle, and it was said that they did not occur in sufficient numbers to do much injury, although they were sufficiently abundant to show that with the increase in cultivation of its food plant the species might in time develop into a troublesome pest.

In his report for 1891 (1892, p. 202), the same writer gives additional notes in regard to the occurrence of this species in Northwest Territory and Manitoba. Extracts from correspondence are given from six different localities showing attack on turnip, cabbage, and radish, it being noticed that rutabaga was very little troubled, provided other more preferred crucifers were available. The choice food plant appeared to be rough-leaved varieties of turnip in preference to smooth-leaved varieties and some other plants.

In his report for the following year (pp. 152–155) Dr. Fletcher gave a still longer account of this species, with extracts from correspondence from several sources and detailed descriptions of the different stages with references to European publications.

In 1893, according to the same writer's report for that year (1894, p. 17), the species again attracted attention, it being noticed that the beetles made their first appearance according to Mr. Thomas Copland, Saskatoon, Northwest Territory, June 17, and that the beetles fed

upon a common cruciferous weed, the prairie wall flower (*Erysimum parviflorum*).

Brief mention is made of this insect by Dr. Fletcher in the Transactions of the Royal Society of Canada for 1899–1900 (vol. V, 2d ser., p. 212).

NATURAL HISTORY.

From the sources of information that have been furnished, it appears that eggs are laid normally in autumn, although sometimes earlier, and that the species hibernates in this stage. The larvæ hatch in early spring long before cultivated crucifers appear above ground. According to Dr. Fletcher, the larvæ feed both in the daytime and by night, and are comparatively active, although, as is well known, the larvæ of the larger leaf-beetles are mostly rather sluggish. When disturbed they drop from their food plant.

The beetles seem to make their first appearance in the Northwest Territories during July and August, and do their worst injury throughout September, continuing in the field in some instances as late as October. The occurrence of the beetles in the latter part of June, as noted by Mr. Gregson, at Waghorn, is perhaps rather exceptional.

Eggs are laid in clusters, loosely fastened together in the same manner as those of the Colorado potato beetle, and are deposited under clods or in cracks in the soil in similar locations.

Larvæ have been noticed to bury themselves in the earth to a depth of about an inch, and to change at once, in small smooth cavities, to pupæ.

REMEDIES.

The measures to be employed for the destruction of this turnip beetle are practically the same as those used against the Colorado potato beetle. Paris green is the best of these, and may be applied dry, mixed with from ten to twenty parts of cheap or spoiled flour, fine plaster, or air-slaked lime; or as a spray, mixed with lime or Bordeaux mixture at the rate of a quarter of a pound of the Paris green to 40 gallons of the diluent. In order to insure success, where the insect abounds in great numbers the wild food plants of the insect should also be treated.

Hand-picking or jarring the beetles from infested plants into pans or other receptacles containing a little water on which a thin scum of kerosene is floating may also be employed. It follows, as a matter of course, that rotation of crops is advisable; and the planting of crops subject to the attack of this species, particularly crucifers, should be avoided in the vicinity of wild plants affected by the same species.

THE CROSS-STRIPED CABBAGE WORM.

(*Pionea rimosalis* Guen.)[a]

This destructive enemy of cabbage and other cruciferous crops, after an apparently complete absence from the neighborhood of the District of Columbia in 1899 made its appearance in great numbers in May and June of 1900 in different fields of cabbage at Brookland, D. C., and was found later in most gardens in which cabbages were grown in near-by localities in the neighboring States of Maryland and Virginia. In nearly every case that came under notice that year the species was much more abundant on cabbage than the larva of the common imported cabbage butterfly (*Pieris rapæ*), and it was noticed that although it works in much the same manner as this latter species, it dug still more deeply into the heads, and in many cases completely destroyed cabbage by eating out the hearts while young and tender.

The insect continued to be the most destructive cabbage pest in this vicinity until late August, when it was replaced by the cabbage looper, and in some restricted localities and on other plants than cabbage—horse-radish, for example—by the harlequin cabbage bug.

This species first became known as an enemy of cruciferous crops over twenty years prior to the date of writing, but since that time has not attracted the attention that would seem to be warranted by its manner of attack. For some reason it does not seem to have multiplied to any great extent during that time, except locally, until 1900. When conditions favor its increase there is no reason why it should not take rank as one of the foremost cabbage pests.

DESCRIPTIVE.

The moth is pale ocher yellow in color, the fore-wings much suffused with fuscous and brownish black, the pattern formed being about as shown in fig. 12, *a*, subject to some variation. The hind-wings are paler, nearly transparent except at the anterior angle, where they are infuscated. There is also a row of five or six small, dusky spots between the middle of each hind-wing and the inner border. The wing expanse is about 1 inch (25^{mm}), and the length of the body less than half an inch (10^{mm}).

The eggs (fig. 12, *b*) are laid in masses, and, being flattened and overlapping like the scales of a fish, strongly resemble the masses deposited by Tortricidæ. The outline of an individual egg is rounded oval, the longest diameter being 1.2^{mm} and the shortest diameter 0.9 to 1.0^{mm}. The eggs are rather bright light yellow in color, and so thin that the green of the leaf on which they are deposited can be seen through

[a] This species has been restored to the genus Evergestis by Sir G. F. Hampson (Rev. Pyraustidae, Pt. II, Pr. Z. S. Lond., p. 186, 1899), and the genus Pionea is reserved for other species.

the middle, the yellow color showing strongest about the margins. The sculpture is fine, but strong and very irregular, the areas showing as irregular triangles, quadrangles, and pentagons (*c*). They are usually deposited on the under surface of the leaf and in masses of from one to two score, although smaller masses of from two to three or five eggs are not uncommon.

The newly-hatched larva is nearly uniform gray in color, with small black tubercles and no visible evidence of striation. The head is round and prominent and nearly twice as wide as the body, and the hairs of the body are sparse and about as long as the width of the head.

The full-grown larva.—The larva when mature is bluish-gray above, with conspicuous transverse black stripes. The head is yellowish or light brown, the thoracic plate mottled (fig. 12, *d*), and each segment has three or more well-defined, nearly straight or curved, transverse stripes. (On the second and third thoracic segments the first stria curves forward between the anterior tubercles.) The dorsal tubercles,

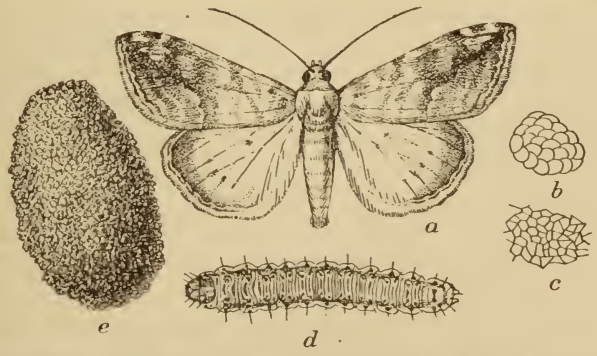


FIG. 12.—*Pionea rimosalis: a*, moth; *b*, egg mass; *c*, sculpture of egg; *d*, larva; *e*, cocoon—*a*, *d*, *e*, twice natural size; *b*, much enlarged; *c*, more enlarged (original).

of which there are two pair of prominent ones in each segment, are gray, partially encircled with black. There is a wide stigmatal line of bright yellow extending from the second to the last segments, and above each spiracle there is a large prominent black tubercle. The ventral surface is green, somewhat mottled with yellowish, and the tubercles bear each a long, black hair about half as long as the width of the body. In form the larva is subcylindrical, moderately slender, about six times as long as wide, and the segments of the body show strongly at the sides. The length of the mature larva is about six-tenths of an inch, 15^{mm} in repose, 17^{mm} when fully extended, and the greatest diameter is about 2.5^{mm}.

The pupa is of the usual pyraustid form, the wing-cases and head dark brown and the abdomen light yellowish brown. "Head small, rounded, with a slight transverse notch anteriorly; wing, antennal and posterior leg-sheaths extending nearly to tip of fifth abdominal joint. Abdominal joints with sutures plainly marked, the two terminal joints

closely welded together and forming a conical tip, at the extremity of which are two very minute brown tubercles" (Riley). The length is 11 to 12^{mm}, or a little less than half an inch.

The cocoon.—Transformation to pupa takes place in a cocoon formed of earth and constructed near the surface. The appearance of a cocoon is well illustrated at *e* of figure 12. The measurement is a little less than five-eighths of an inch in length, and three-eighths of an inch in diameter. The outer grains of sand are rather loosely held together, but the interior is fairly substantial, the lining being of light-gray color, nearly white.

DISTRIBUTION.

So far as the writer is aware, no comprehensive list of localities of this species, or other data that give any idea of the insect's distribution, have ever been published. From material received at this office and at the National Museum, and from reports of correspondents, the following list of localities has been compiled:

Newark and Dover, Del.; Cabin John, Marshall Hall, and elsewhere in Maryland; Cameron's Mills, Carterton, Chesterbrook, St. Elmo, and Alexandria, Va.; Brookland and elsewhere in the District of Columbia; Lexington, Ky.; Springfield, Ohio; Aurora and Lafayette, Ind.; Mount Juliet, Tenn.; Carbondale and Anna, Ill.; Raleigh, N. C.; Montreal, Athens, Macon, and Storeville, Ga.; Alabama; Lone Star, Oxford, and Agricultural College, Miss.; West Point, Nebr.

From the above list it would seem that the southern distribution of this species and its southern origin are well established. The moth has been recorded as occurring farther west and north, but injurious occurrences are lacking, at least in reports of injuries sent to this office. It seems, therefore, that the species attains its highest development in the Lower Austral life zone, although occasionally it invades the Upper Austral and even, perhaps, the Transition area. This, however, is only temporary.

RECENT INJURY.

During 1899 we received this species from Mr. E. Dwight Sanderson, at that time at Raleigh, N. C., September 18. They were found in numbers on cabbage. July 28, Mr. S. S. Simms, Storeville, Forsyth County, Ga., sent this species, also found on cabbage. September 18, Mr. Thos. I. Todd, Athens, Ga., sent the species, with the accompanying information that it did great damage that year feeding in the buds and tender leaves of cabbage and turnip, and stated also that it was known as "the common webworm," in contradistinction to the imported cabbage webworm (*Hellula undalis*). He stated that this species succumbed to Paris green and pyrethrum dusted upon the plants, where the imported species did not.

In 1900, Mr. J. H. Heard, Montreal, Ga., sent this cabbage worm, July 5, with information that it was concerned in attack on cabbage

in that vicinity. We received, August 6, specimens of this species from Dr. E. K. Harding, Carterton, Va., where they were attacking cabbage.

NUMBER AND OCCURRENCE OF GENERATIONS.

Observations conducted during the season of 1900 indicate the presence of four generations in the District of Columbia and vicinity. From larvæ obtained in the latter days of May and in early June in different fields of cabbage, in and near the District of Columbia, moths were obtained during the last days of June and until July 6.

The second generation produced from the first of these moths and placed in a rearing cage July 2, issued August 1, having passed all stages in just thirty days, which will come very near to being the minimum period for this latitude, since the heat was excessive during the greater part of the month of July.

The third generation began to appear in the rearing cages, on September 1, from moths which issued August 1, or in thirty-one days, the temperature during that period, with the exception of a few days, having been about the same as in July.

The fourth generation, as might naturally be expected, failed to develop in confinement, and it seems probable that this was the last generation produced in the field. This was only apparent, however, for after repeated failures to find the larva in the field, a colony was taken September 21 in a small head of cabbage. This last colony was obtained on the Department grounds, and was evidently the progeny of moths which had purposely been liberated from our rearing jars, so that it represents in all probability the normal fourth generation.

It must not be supposed from the above that there is any such regularity of development except in a single season and in a given locality. At other times, from specimens gathered where the temperature was somewhat different, moths were reared July 14; larvæ were obtained, nearly all mature, July 30. From other lots moths have issued August 9 and 10. In one instance larvæ were noticed to mature August 20, and to develop as moths September 1, giving ten days for the period occupied by the larva in the cocoon. Perhaps two or three days elapsed before the larvæ changed to chrysalides. In still another case larvæ were found to enter the earth August 29 and 30, and moths developed September 9, giving about the same period as just mentioned.

SUMMARY OF LIFE HISTORY.

Observations conducted by the writer go to show that in many respects this cabbage worm, although the larva of a moth, conforms very closely in its life economy to the imported cabbage butterfly. It is attacked by some of the same natural enemies, and appears to differ from the imported species only in unimportant details. Like

the imported worm, it makes its first appearance some time in April in the vicinity of the District of Columbia.

The eggs hatch in six days in hot July weather, a longer time being required in a cooler atmosphere. The stage passed in the cocoon in warm weather has been observed to be ten days. Part of this time the larvæ were probably quiescent. The exact pupal stage was not observed, but probably varies from six days to considerably longer, according to temperature. The period of the larva varies from two to three weeks, and perhaps longer in cool weather.

NATURAL ENEMIES.

The cross-striped cabbage worm is subject to the attack of small four-winged parasites of the genus Apanteles, and a few other natural enemies, including wasps, destroy it.

Apanteles congregatus Say is recorded as having bred from material received in 1880 from Mississippi (Report Com. Agr., 1883, p. 127).

A. utilis French was reared from material received from Lone Star, Miss., October 17, 1879 (Insect Life, Vol. III, p. 16).

A. xylina Say was reared from cocoons on and with its host by Dr. A. D. Hopkins, Morgantown, W. Va., July 26. Of this latter occurrence, Dr. Hopkins (l. c., Vol. IV, p. 259) remarked: "This species was found plentifully wherever the host was observed. Gardeners generally were destroying the cocoons, supposing they were the eggs of the caterpillars."

A. læviceps Ashm. issued September 30 from larvæ obtained in 1899 from Athens, Ga.

A. alamedensis Ashm. was reared July 16, 1900, from larvæ obtained from Montreal, Ga., and sent to this office by Mr. J. H. Heard. Fully half of the larvæ (a large number) were parasitized.

Meteorus indagator Riley MS., issued from material received from Oxford, Miss., September 1880 (l. c., Vol. III, p. 59).

REMEDIES.

In treating this species it should be borne in mind that "worms" of other species as well as other cabbage pests are more often present than otherwise.

Arsenicals.—The best remedy is Paris green applied either dry or wet, preferably, however, as a spray, at the rate of about one pound of the poison to 150 gallons or a little less of water, and it should be used when the plants are first set out, to insure its reaching the young larvæ or caterpillars before they have burrowed far into the heads; in other words, this poison should be applied in the same manner as for the imported cabbage worm, as the two species have much the same habits. Other applications should follow frequently, as required, and can be made with safety until the heads are about half formed, and

even later, as the poison, under ordinary circumstances, disappears from the plants within three or four weeks after being applied.

Bran mash.—A mixture of bran with Paris green, a standard remedy for cutworms and grasshoppers, is, according to the testimony of those who have used it, successful against cabbage worms. It is best to mix the bran with water and sugar before adding the poison. The proportions are two or three ounces of sugar or other sweetening, and a sufficient amount of bran (about one pound to the gallon) to make, when stirred, a mixture that will readily run through the fingers. This is to be sprinkled either wet or dry upon affected plants.

Kerosene emulsion has been used for many years against the imported cabbage worm, but is not as efficient as the arsenicals, because it is necessary for this spray to come into direct contact with the larvæ, in other words, to hit them in order to kill them.

Pyrethrum has been used for some years as a remedy against the common cabbage worm, and is of use against the present species. It has the advantage of not being poisonous to human beings, but is said by some cabbage growers to discolor the leaves, and if its use is not continued at frequent intervals the larvæ recover and continue their destruction. It is therefore more expensive than the other remedies that have been mentioned.

Mechanical methods.—For small gardens where for any reason it may be undesirable to use arsenicals hand-picking can be practiced and is of especial value when the plants are first set out.

The corn-meal remedy.—Corn meal dusted on cabbage, according to the testimony of Prof. Lawrence Bruner, causes the worms of the imported cabbage butterfly to drop off and protects cabbage and other crops until washed off by rains. It is advised to apply it in the morning while the dew is on. The meal acts as a deterrent.

Clean cultivation and trap crops.—If cooperation in clean farming could be secured, together with the use of arsenicals, the losses due to the ravages of this as well as other leaf-feeding pests of cabbage might be largely averted. The practice of leaving cabbage stalks in the field after the main crop has been secured is reprehensible. Remnants should be gathered and destroyed, with exception of a few left at regular intervals through a field as traps for the females for the deposition of their eggs. These plants should be freely poisoned with arsenicals, where feasible, so that the last generation will not develop.

Water as a remedy.—Washing the plants with a stiff stream from a hose is of value where this can conveniently be done.

Hot water at a temperature of about 130° F. has been advised as a remedy against cabbage worms. Applied at this temperature it does practically no harm to plants and destroys all insects with which it comes in contact.

THE CABBAGE LOOPER.

(*Plusia brassicæ* Riley.)

The remarkable scarcity of this species during the entire spring, summer, and autumn of 1899 has been mentioned in an earlier article (Bul. 22, n. s., p. 59). It was, therefore, a cause of considerable surprise to find larvæ in abundance during the last week of November in 1900, the work of this species and *Pieris rapæ* being quite noticeable on the older leaves of cabbage. The finding of larvæ only a quarter grown showed that eggs had been deposited during the month.

Larvæ were kept in a cool indoor temperature and fed freely on cabbage leaves. All but one, however, sickened and died within a week after capture. The last larvæ of this lot died when full grown, December 11. Numerous larvæ, however, were still living in the fields where this species was under observation, all of the living ones observed being in first-class condition December 13. One larva was found less than half grown, showing that eggs had been deposited about the last week of November.

The cabbage looper is an unusually voracious species, developing rapidly, and a single individual is capable of doing considerable damage, as when at work on pea. On cabbage, while the larvæ are feeding on the outer leaves, the plant can more readily withstand defoliation. One looper was noticed to eat more than its own bulk each day.

DESCRIPTIVE.

The moth which produces this looper is of somewhat obscure appearance, although its markings are fairly regular and constant. The upper wings are grayish brown, mottled with gray, whitish, and blackish. Just on the inner side of the inner half of the wings there is a variable white mark, looking, particularly in the male, something like the letter Y. The hind-wings are paler brown, with the latter half more or less infuscated, and both wings are strongly scalloped, as shown in the illustration. The veins of the hind-wings are rather strongly defined. The lower surface is pale brown, and both the upper and lower surfaces are shining. The wing expanse varies from about an inch and one-eighth to an inch and three-eighths.

The egg.—The egg is silvery white in color, with no appearance of iridescence, and as it rests upon a green leaf, the color of the leaf showing through causes it to appear pale green. It is of the usual semiglobular Noctuid form, the surface strongly marked with radiating vertical ribs, about forty-eight in number as counted from the sides from which they project rather feebly but distinctly, and forty as counted from above where some vanish. Cross striæ are not distinct, but the spaces between the ribs are filled with rounded concave areas. The lower surface of attachment is nearly smooth and not ribbed. The diameter is about 0.6^{mm} and the height 0.4^{mm}.

The larva derives its name of looper from its habit of "looping" in walking, due to the absence of legs on the sixth and seventh segments. It is from the first a pale-green, fragile-looking creature. It varies considerably in color when mature; a large proportion of specimens that have come under observation are darker green than normal, and these are usually rather more strongly marked with the white lines shown in figure 13 at *c*. Upon attaining full maturity the longitudinal white lines frequently disappear. In some individuals also there are rounded spiracular spots on the three thoracic segments.

An immature larva is shown in figure 14.

The cocoon and pupa.—When the larva becomes full grown it constructs for pupation a remarkably fine, white, gauzy cocoon, which it usually attaches to the broad surface of a cabbage leaf or other plant on which it has fed. Strictly speaking, this is seldom a perfect cocoon, although some such can be found, as it uses the surface of the leaf for protection on one side and the gauze on the other. It seems probable that this is quite efficient against many of its enemies; and it is in the larval stage that the insect usuually succumbs to the numerous natural enemies which will presently be mentioned. The chrysalis varies somewhat in color, being rather pale for a Noctuid, the wing-pads moderate brown, and the abdominal segments yellowish. The total length is a little less than three-fourths of an inch. It is shown in its cocoon at *d* (fig. 13).



FIG. 13.—*Plusia brassicæ*: *a*, male moth; *b*, egg shown from above in upper figure and from side in lower; *c*, full-grown larva in natural position feeding; *d*, pupa in cocoon just before development of moth—*a*, *c*, *d*, about one-third larger than natural size; *b*, more enlarged (*a*, *c*, *d*, adapted from Howard; *b*, original).

TECHNICAL DESCRIPTIONS OF THE STAGES OF THE LARVA.

Stage I.—Head higher than wide, bilobed, mouth projecting, clypeus high, nearly reaching vertex. Antennæ long; free from joint 2, somewhat flattened; luteous brown, the sutures of clypeus dark brown, area around mouth black, epistoma reddish, antennæ pale; width 0.25mm. Body slender, moniliform, smooth. Whitish, translucent, pale green from the blood. Abdominal feet on joints 9, 10, and 13. Cervical shield trapezoidal, black, small but distinct. Thoracic feet blackish, abdominal ones grayish outwardly, no distinct shields. Joint 12 enlarged. Tubercles

small but round and distinct, normal, no subprimaries. ia to iib on thorax separate, iv of abdomen below the corner of the spiracle, halfway to v on joint 11.

Stage II.—Head higher than wide, mouth broad projecting, squarish shallowly bilobed, flattened before. Green, the broad sutures of the high clypeus blackish; width 0.45mm. Large ocelli black, in a close semicircle, jaws reddish. Body slender, moniliform, joint 12 enlarged dorsally. Feet on joints 9, 10, and 13. Translucent green, a narrow white subdorsal (below tubercle ii) and stigmatal lines. Tubercle iii on joints 5 to 7 and less so on 8, enlarged, black. Others also black but minute. Setæ long, black, pointed; subprimaries present, normal. Feet all pale and concolorous; no shields.

Stage III.—Head high, flattened before, held obliquely, vertex against joint 2, clypeus two-thirds to vertex, the paraclypeal pieces broader than before and concolorous with the head. Antennæ moderate, blackish ringed. Green, ocelli black, whitish ringed, setæ black; width 0.7mm. Body humped up in the legless part; joint 12 slightly enlarged. Green, tubercles whitish with narrow black hair points, iii on joints 5 to 7 somewhat larger and black, largest on joint 6, not very conspicuous. Fine, irregular white lines, viz, geminate dorsal, small and subobsolete, addorsal (above ii), subdorsal (below ii), and stigmatal somewhat broader than the others yet narrow. Setæ blackish, rather long. Tubercles of joint 12 somewhat enlarged. Feet absent on joints 7 and 8. Thoracic feet brownish at tips. Spiracles pale, concolorous; tubercle iv below the stigmatal white line.

Stage IV.—Head as before, green, ocelli black centered; width 1.2mm. Body slender, joint 12 a little enlarged; feet on joints 9, 10, and 13. Cylindrical, incisures a little narrowed. Translucent green, the ♂ sex glands in joint 9 large, pale yellow,

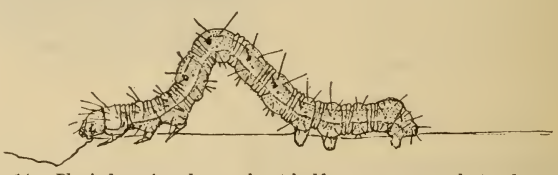


FIG. 14.—*Plusia brassicæ:* larva about half grown—somewhat enlarged.

conspicuous. White addorsal line narrow, a broader subdorsal (above ii, over i), narrower lower subdorsal (below ii and near the subdorsal), narrow white stigmatal lines, all as before. Tubercles distinct, a little elevated, small, white, iii of joints 5 and 6 black. Feet concolorous, claspers and spiracles whitish; no shields. Setæ blackish, rather long. Tubercle iv behind the spiracle on joint 5, below the lower corner on 6 to 8, opposite the corner on 9 and 10, halfway to v on 11, at the lower corner on 12. Tubercles i and ii on joint 12 in a square. Lines irregularly edged and broken at the extremities.

Stage V.—Head rounded squarish, slightly bilobed, flattened before, oblique, free from joint 2. Translucent shining green, antennæ and palpi yellowish, ocelli black; width 1.8 to 2mm. Body normal, moderate, joint 12 enlarged dorsally. Green, no shields marked with white lines. Addorsal narrow, crinkly; subdorsal (between i and ii) broader, upper lateral (below ii) and stigmatal narrow. Tubercles white, iii of joints 5 to 7 black, but small and inconspicuous. Spiracles white, narrowly black-rimmed. Feet green, the abdominal ones on joints 9, 10, and 13. Tubercle iv below the spiracle. Setæ blackish but obscure. The larva occasionally comes darker colored. The ground color is darker green, more transparent, especially along the dorsal vessel and above the stigmatal line, making the lines more contrasted and whiter. Tubercles iii are black the whole length, largest on joints 6 to 8, but plain on 5 to 12. Head brownish on the lobes.

(Larva had only 5 stages.) [H. G. DYAR.]

DISTRIBUTION.

Although the cabbage looper remained undescribed until 1870, and there is no doubt that it is a native species, it has now become widely distributed throughout that part of the United States lying east of the Rocky Mountains, together with Utah, and from Maine to the Gulf. It is probably of somewhat remote southern origin, and is much more destructive in the southern portion of its range than in the most northern, if we except a few localities like New Jersey and Long Island, where it is periodically troublesome. We have no reports of destructive occurrence in Maine, and it is possible that the species is recorded only from fugitives there; and the same applies to some other northern localities which appear in our divisional records. The moth appears to be a strong flyer, and has been recorded as far north as Winnipeg, Manitoba (Hanham), from captures; but it does not seem probable that injury has been committed there.

RECENT INJURY.

During the past three years much complaint has been made of the ravages of cabbage "worms," but, as a rule, the letters of complaint have not been accompanied by specimens, and we have thus not been able to identify the species. It seems probable, from the abundance of the cabbage looper, that this insect was often the cause of injury, although attack is frequently complicated by the presence of *Pieris rapæ*, the common imported cabbage worm, and other species.

During the year 1899 we received complaints of this looper from Athens and Montreal, Ga., and Rollover and China Spring, Tex. Mr. James I. Todd, of Athens, Ga., reported that in his locality this caterpillar fed mainly on the older and lower leaves of cabbage, turnip, and rutabaga, but did nearly as much damage during 1899 as *Pionea rimosalis*, which is treated in another paper in the present bulletin. At Evansville, Ind., where Mr. J. B. Walsh reported this species as injurious during the same year, it was currently reported that the gardeners of that vicinity considered the species new as a cabbage pest. During the next two years we received complaints, accompanied by specimens, from Mr. J. L. Phillips, Blacksburg, Va., who stated that this looper was doing considerable damage to peas near Norfolk, having almost displaced the destructive green pea louse in point of injuriousness. Specimens were also received from Carterton, Va., and Corpus Christi, Tex., in both cases complaint being made of injury to cabbage. In the latter locality this insect was called the common cabbage worm. In the vicinity of the District of Columbia the writer and Mr. Pratt at different times found this larva attacking pea, asparagus, common pigweed (*Amaranthus retroflexus*) growing between rows, lamb's-quarters (*Chenopodium album*), mullein, plantain, and tomato.

ECONOMIC STATUS.

It is nearly as difficult to define the exact status of an insect as regards destructiveness as it is to obtain reliable estimates of its injuries. What is true of one is about equally true of the other. We can obtain reliable information as to the relative injuriousness of an insect compared to others which affect a given crop in a given season over a small area, and we sometimes receive valuable estimates of injuries that have been inflicted over such small areas, but it is only with slight hesitation that the writer places the cabbage looper among the first three cabbage pests of this country, considering what has been written in regard to it. In view of its much wider distribution, its manner of attacking cabbage, and its destructive appearance so much earlier in the season, there can be no doubt that the imported cabbage worm (*Pieris rapæ*) is our worst enemy to cruciferous crops; and next in order comes the harlequin cabbage bug (*Murgantia histrionica*), after which comes the cabbage looper as the third in rank.

Writing of this insect in 1870, Riley stated that, next after the cabbage worm mentioned, this was the most common insect which attacked cabbage in Missouri—a remarkable fact, considering that the species had not hitherto been described (2d Mo. Rept., p. 110). The same author, writing again in 1883 (Rept. Commr. Agric. for 1883, p. 119), said that the larva of this species was the most destructive enemy to cabbage and other cruciferous plants known to the Southern gardener, and shared that distinction with the imported cabbage butterfly as far north as Illinois and New Jersey. Since the time of the publication of that statement, however, the harlequin cabbage bug has become much more widely distributed and injurious, and has alone destroyed many fields of cabbage, as the writer can testify from personal observation.[a]

As previously intimated, owing to the fact that the cabbage looper comes late in the season, its injuries are not so noticeable, as ordinarily it confines itself to the outer leaves of cabbage. It has a much wider range of natural food plants than the other two species mentioned, and there is no doubt that some injuries done by it are attributed to the common cabbage worm, as the latter is better known.

Professor Sanderson has recorded an instance of unusual abundance in Maryland during 1898 (Practical Farmer, December 31, 1898). He states that most of the large cabbage growers of Maryland had lost between 75 and 90 per cent of their crops, and rarely could first-class heads be found in a kitchen garden. When from twenty-five to forty loopers were greedily devouring a single plant, as he frequently found

[a] At the present writing, however, this species is held in check in many localities in its northern range by weather that has been inimical to its multiplication, and it may be a matter of some years before it regains the lost footing.

them, this is not surprising. The writer noticed much the same condition of affairs in portions of Maryland, Virginia, and the District of Columbia which he visited that same year, entire fields being practically failures, the growers not taking the pains to gather any of the plants on account of the ravages of this pest. In most cases, however, the writer had noticed other insects at work earlier in the year, and the loopers took what was left. The following year, as the writer has already recorded, the species was very rare, on account of the extreme cold and the sudden changes of the winter of 1898–99.

LITERATURE OF THE SPECIES.

Comparatively little has been published in regard to the cabbage looper when we take into consideration its excessive injuriousness. In addition to the accounts that have been quoted, Lintner published an article on this species in his Second Report on the Insects of New York (1885, pp. 89–93), in which, however, little is added to our knowledge of it, but the report in question gives a very full bibliography to date; and in Bulletin No. 23 of the Geneva Station, published in 1894, an account, by F. A. Sirrine, is given, on pages 667–671, with photographic illustrations. In 1893 Mr. G. C. Davis (Bul. 102, Mich. Agr. Expt. Sta., p. 27) made the statement that this insect was taken on celery in Michigan, the moth appearing July 14.

In the American Florist for March 3, 1900 (Vol. XV, pp. 912, 913), Mr. Sirrine gave a short account of this looper in connection with injury to carnations, stating that it and the variegated cutworm were the worst of the transient enemies of this plant. Like the cutworm, he writes, it feeds usually at night on the buds. It can be carried in the house on plants, but more commonly the female moth finds her way indoors through open ventilators.

FOOD PLANTS.

This species feeds normally on Cruciferæ, favoring cultivated forms, and, when such are to be had in abundance, it is not often that the loopers feed to any extent on other plants in the same neighborhood. It appears to greatly prefer cabbage and cauliflower, but during its seasons of abundance attacks also turnip, rutabaga, radish, both cultivated and wild, kale, mustard, and the like. Peas are frequently the object of attack, while cowpeas and beets are also eaten. Sometimes the insect is quite destructive to celery and lettuce, and will feed also upon tomato and, less frequently, on asparagus beds, clover, and possibly tobacco.

It is sometimes a pest in greenhouses, when it does damage to carnations, mignonette, and German ivy (*Senecio scandens*). Other food plants include dock, dandelion, lamb's-quarters, Japan quince (*Cydonia japonica*), plantain, mullein, and pigweed.

The pupal period varies greatly, according to the season. Thus, in hot weather in July a number of loopers were observed by the writer to transform to pupæ July 5 and to issue as moths on the 11th, or in six days, the temperature indoors averaging about 85°. Another lot of pupæ taken from celery in the field October 7 did not develop moths until the 29th, or in twenty-two days. The weather was cool, but the temperature was not noted, so it is plain that we have a pupal period, varying according to temperature, of from one to three weeks. No definite records can be found of the duration of the egg or larval periods, but assuming three generations for the Upper Austral zone, where this species seems to attract more attention than in the South, we can safely assume from analogy with the observed pupal periods and other knowledge of related species that the egg period will vary from four to ten or more days, according to temperature; that the larva may undergo all its changes (five stages in number) in from two to four weeks, the minimum of two weeks being estimated from the fact that the larvæ grow so rapidly, and the maximum, four weeks, from our knowledge that the insect breeds later in the season than nearly any other injurious species of its kind.

In reviewing the life history of this species, Dr. Lintner (l. c.) stated that there were only two generations produced during the year, and this is perhaps true of its extreme northern limit. Mr. Sirrine, however, states that it is apparently three-brooded on Long Island, and that hibernation probably occurs both as adult and pupa.

If the last generalization is correct it would seem probable that four generations may possibly be produced in the District of Columbia, but the writer is inclined to believe that there are only three, and that hibernation takes place chiefly in the pupal stage. A fourth generation is evidently attempted, but fails to survive the winter.

The time when the moth makes its first appearance in the District of Columbia or elsewhere appears not to be recorded. Few individuals survive the winter northward, but the propagation of the species is so rapid that by the time autumn is reached great numbers of larvæ are produced which do much damage to crops in cultivation at this time.

NATURAL ENEMIES.

PARASITES.

This cabbage looper is unusually susceptible to bacterial and fungus diseases; it is also preyed upon by birds and other insectivorous animals and by parasitic and predaceous insects. Its most efficient insect destroyer in the field in Maryland, Virginia, and the District of Columbia is a minute chalcis fly (*Copidosoma truncatellum* Dalm.), an imported European parasite, which has evidently selected this

looper as its favorite host in this country. In Europe this chalcis fly is also particularly attached to the genus Plusia, although known to parasitize larvæ of several other genera of Noctuidæ as well as other families. The habits of this parasite were described by Dr. Howard in the American Naturalist for February, 1882 (pp. 150, 151). An interesting instance of its value as a destroyer of the looper is cited in the annual report of this Department for 1882 (1883, p. 121). In the fall of 1880 nearly fifty larvæ were collected, with the intention of rearing the moths, but all, with a single exception, were eventually destroyed by this parasite, only 2 per cent of the larvæ having reached the imago state. As parasitized loopers approach full growth they lose their characteristic pale longitudinal stripes and become uniform pale green or yellow in color. As a rule, in the writer's experience, the larvæ spin up before succumbing, and in a few days parasitism by this chalcis fly is clearly evident, since the pupæ do not develop and the larvæ assume a peculiar twisted form. Almost without exception the bodies of the parasitized larvæ are completely filled with these almost microscopic parasites. By actual count 2,528 chalcis flies issued from a single parasitized larva. In recent experience the parasitic flies have been reared only from their host during the last week of September and in October.

Apanteles congregatus Say, a well-known parasite of the imported cabbage worm (*Pieris rapæ*) and other noxious species has been reared from this looper.

It has been noticed on several occasions that when the larva of the looper forms its characteristic gauzy white cocoon on other plants than those on which larvæ have fed, the individual is usually diseased or parasitized. Thus, on one occasion the writer took five chrysalides from eggplant, although no evidence whatever could be found that the larvæ had fed on this plant. Larvæ were found on eggplant, but not feeding, and all of these, although kept in the best of condition, died of disease or were parasitized by the *Copidosoma truncatella*. It may be interesting to note of this parasite that the adults issued in late September, sixteen days after their detection in the body of the host. At Brookland, D. C., on one occasion all of the pupæ that could be collected were parasitized, an evident case of complete parasitism.

PREDACEOUS ENEMIES.

A medium-sized white-spotted black spider, *Phidippus audax* Hentz., was observed by the writer July 13, destroying the moth of this insect. This spider appears to be specially adapted to prey upon Plusia, since the web spun by it looks almost precisely like that of the looper. Other species of spiders crawl into the empty cocoons of the moth, and it seems probable that they feed on the larvæ also when these are just about to transform.

Several species of Carabidæ and other predaceous Coleoptera have been recorded to occur in badly infested cabbage fields, with the presumption that they had been feeding on the looper. (Rept. Dept. Agr. 1883, p. 120).[a]

Mr. J. B. Dunn, Corpus Christi, Tex., wrote that he knew of only one insect that fed on this worm, a large black beetle locally known as "pinch bug." This insect was not sufficiently abundant, however, to keep the looper in subjection. Specimens kindly sent to this office proved to be the larva of a species of Calosoma, probably *calidum*, and the beetle *Pasimachus californicus*. He also wrote October 14 that a bird locally known as jackdaw, and which Dr. C. H. Merriam identifies as either the great-tailed or boat-tailed grackle (*Quiscalus macrurus* or *Q. major*), was particularly fond of these cabbage loopers. These birds would alight in the fields and feed on the larvæ daily until they would "clean them up and save the crop." During recent years, however, hunters and others had slaughtered these birds to such an extent that they now shunned civilization. Our correspondent thought this bird deserved protection.

DISEASES.

Bacterial disease.—During July some recently collected larvæ were found to be suffering from a disease. A larva thus affected first grows pale and yellow, and in a very few hours becomes weak and flaccid, upon death assuming an ashy gray color, which later may turn to brown or blackish. Diseased larvæ usually become fastened by the prolegs to the plant upon which they have fed, and hang head downward, in time often becoming a putrid mass much like that observed of the common cabbage worm when diseased. In the jar in which these larvæ were fed a cabbage leaf had been placed which was not quite fresh, and, evidently as a result of feeding upon that, the remaining larvæ contracted the distemper, and all were dead two days after the first appearance of infection.

Diseased larvæ were referred to Mr. B. T. Galloway, Chief of the Bureau of Plant Industry, who wrote that, to the best of his knowledge, the organism concerned in the infection had never been described or named, but was apparently a species of bacillus.

What is perhaps the first mention of a disease of this insect, and probably the same as under present observation, was by Prof. Herbert Osborn (Bul. No. 30, n. s., 1892). He states briefly that larvæ were attacked by a disease that swept off many of them. In Mr. F. A. Sirrine's account, previously cited (l. c., p. 670), mention is also made of the disease and its occurrence in 1894 on Long Island. Mr. Sirrine

[a] The following is the list: *Cratacanthus dubius, Harpalus caliginosus, H. faunus, H. pennsylvanicus,* and the larvæ of *Collops quadrimaculatus, Hippodamia convergens,* and *H. parenthesis.*

states, however, that it was not noticed until the cold, wet weather of October and November set in. It should be added that the writer observed the same disease upon Plusia in the field during the last week of July, and that pupæ also suffered from it. This disease is readily communicable from one larva to others, and it frequently happens that if a diseased one is placed in an ordinary tin collecting box over night all of the others that may be confined with it develop the disease in a day or two.

Fungus disease.—One of the fungus diseases from which Plusia larvæ die is *Botrytis rileyi* Farlow. The affected worms, according to Riley, become sluggish and then die, after death appearing stiff and brittle and firmly attached to the leaves or stems upon which they have died. They are profusely covered with a greenish mold.

REMEDIES.

The same remedies as advised for the cross-striped cabbage worm should be used against the present species. It should be observed, however, for the benefit of our correspondents, that they must be used with great persistency at frequent intervals in order to insure perfect success, and should be applied to the lower surface of the outer leaves. The killing off of the first generations of the insect should be particularly observed, but this will be of little or no avail if other cabbage growers within several miles of the same locality do not take the same precautions. One of our correspondents, Mr. Dunn, previously referred to, tried Paris green and lime, and succeeded in killing all of the common cabbage loopers.

Notwithstanding this, however, the writer noticed during September, in the vicinity of the District of Columbia, an entire field of cabbage which had been liberally dusted with Paris green and plaster mixed at the usual rate of 1 pound of poison to 20 pounds of plaster, with no perceptible effect upon these insects. The first application had been made about two weeks previous, another had been made within five days, and yet the larvæ were feeding quite contentedly on the lower surfaces of the leaves in their usual manner and no dead were to be found under the plants or elsewhere. This simply indicates that the poison, as previously stated, should be applied to the lower surface, and preferably in the form of a spray. Mr. Pratt, who observed this species at Chesterbrook, Va., noted the same results. After a rainfall eggs hatch, and the larvæ are able to do injury without being affected by the poison.

A NEW CABBAGE LOOPER,

(*Plusia precationis* Gn.)

The larvæ of this species in different stages of growth were observed during 1899 and 1900 attacking cabbage and some other plants in two gardens in the District of Columbia. The same insect was observed

the previous year in less numbers in the same gardens. Cabbage does not appear to be recorded as a food plant of this insect, and in fact its habits are little known.

RECENT ATTACK.

June 1–3, 1899, this species first came under the writer's notice, when a few larvæ nearly grown and several less mature were observed on cabbage. June 5 an immature individual was brought to the writer by Mr. T. A. Keleher, of this office, who found it feeding on cultivated morning glory, and June 19 a larva was taken by the writer feeding on common pigweed (*Ambrosia artemisiæfolia*). The individuals found were so few in number that it was impossible to trace the species through its life history. The following June, however, larvæ were present in greater abundance, all on cabbage.

DESCRIPTIVE.

The moth of this species is a little larger and more graceful than that of the cabbage looper. The general color of the fore-wings is a beautiful bright shining brown, variegated with bronze, purple, and pale-fawn color. The fore-wings are not so strongly scalloped as in the species mentioned, but the hind-wings are similarly colored, and

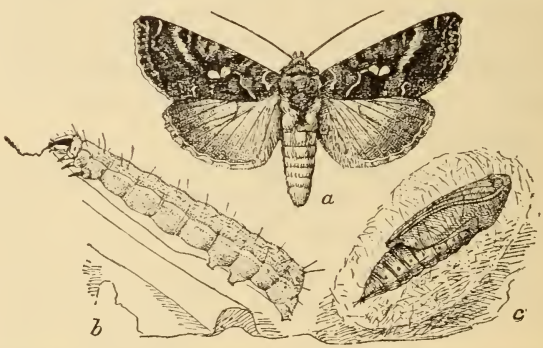


FIG. 15.—*Plusia precationis:* *a*, female moth; *b*, larva extended, feeding; *c*, pupa in cocoon—all somewhat enlarged (original).

the veins are equally noticeable. In the common looper the white spots on the fore-wings are chalky-white, while in this species, although they are of very similar form, they are decidedly silvery, and the two portions are usually well separated (see fig. 15, *a*.) The thorax is also brown, and the abdomen fawn-colored, while the lower surface is similarly but a little more strongly marked than that of the common looper. The wing expanse of specimens at hand shows a variation from an inch and an eighth to nearly an inch and a half.

The penultimate stage.—In next to the last stage this larva lacks the characteristic markings of the mature form. It is very much more slender, and looks, in fact, more like a Geometrid than a Plusia.

It is of nearly the same green color, but the sides of the head and the legs are not marked with black. There are two white undulating stripes on each side of the middle of the dorsum and a broad yellowish white stripe above the stigmata. In most individuals one or more of the abdominal segments bear on each side a black suprastigmatal tubercle.

The last stage.—In the last stage the larva may be readily distinguished from the common cabbage Plusia by the long eye-like elliptical spots on each side of the head. The hind pair of thoracic legs are nearly black, the middle pair a little lighter, and the front pair still paler. The dorsum is mottled with white, the lines being irregular, and the dorsal tubercles, of a green color, being quite prominent. The lateral stripe of the abdomen is broad, white, and well defined. In some individuals on the first two or three abdominal segments the suprastigmatal tubercles are black, but imagos hatched from larvæ thus colored look no different from those hatched from unmarked larvæ. There is also considerable difference in the arrangement of the white marks on the back, the same being true of the common cabbage Plusia. In some individuals these white marks show as four strong undulating stripes, while in others half a dozen or more very irregular striped markings are seen. In one individual the black lateral spot on the head was much less strongly defined than in the others. When fully matured the larva measures in its natural slightly curved position about one inch in length. In figure 15, *b*, a larva is shown extended in a position which it often assumes.

The pupa (*c*) does not appear to have been described. It is not likely that it differs in any important particular from that of *P. brassicæ*.

The eggs have not been compared with those of *P. brassicæ*, but it is more than probable that they are nearly identical, and, in fact, the species differs very little in structure and life history from that of the common cabbage looper.

DISTRIBUTION.

Smith states that this species occurs in the United States east of the Rocky Mountains from May to October, also in Canada. Exact records of localities are rather meager. They include Canada; Cambridge, Mass.; Sharon, Pa.; Dayton, Ohio (Pilate); Woodstock, Ill.; Wisconsin; and the District of Columbia. Hanham states that this species is rare at Winnipeg, Manitoba. It does not seem probable that the insect breeds there, but is merely a stray from a more southern and congenial locality.

HISTORY OF THE SPECIES.

The biological literature of this looper is quite limited, which is to be explained by its seldom having been found attacking useful plants.

In the year 1869 Dr. A. S. Packard made mention of this species in

his first edition of the Guide to the Study of Insects. He states on the authority of Mr. Saunders that the larva, of which he gives a brief description, feeds on the hollyhock in August. He also makes mention of Plusia larvæ figured by Glover in his work on insects injurious to the cotton plant, but as this work was never published, in the true sense of the word, it need not be further mentioned here.

In the late Dr. Riley's second Missouri Report (p. 112), published in 1870, this species is briefly treated in connection with a discussion of *Plusia brassicæ*. He states that it occurs commonly on thistles and proposes the name of thistle Plusia. The larva is said to differ from the cabbage Plusia only in having the sides of the head, the thoracic legs, a row of spots above the lateral light line, and a ring around the breathing pores, black.

In the Canadian Entomologist (Vol. XIII, pp. 21–23) for February, 1881, Mr. D. W. Coquillett, now of this office, published an article entitled, "On the early stages of *Plusia precationis* Guenee." Subsequently, in the same publication (Vol. XIV, p. 60), Mr. Coquillett calls attention to the wrong identification of the species, the insect which he had under observation being *P. simplex* and not *precationis*.

The species is again referred to in connection with a consideration of *Plusia simplex* by Mr. Coquillett in the Eleventh Report of the State Entomologist of Illinois in 1882 (pp. 38–42). From studies made at that time of the larvæ of these three species of Plusia, deductions were made that *Plusia simplex* differs from *brassicæ* only by the black rings around its breathing pores, and that both of these larvæ differ from *precationis* by lacking the black stripes on each side of the head. Unfortunately, as the writer has previously observed, some examples of *brassicæ* also have these black rings about the breathing pores.

No extended observations have been made on the life history of this species, but it is probable that it will be found to agree perfectly with *P. brassicæ* when it occurs in the same localities. Such individuals as were under observation by the writer transformed to pupæ in seven, eight, and eleven days, pupation beginning in three instances in early June, and in two in late June, the eleven-day period being passed in unseasonably cool weather.

It should be added that there is in the National Museum a moth reared October 4, 1882, on *Gerardia pedicularia* (presumably in the District of Columbia), and of a Proctotrypid, bred from the cocoon of this species March 29 of the same year.

The name of eyed-cabbage looper is proposed for this insect.

REMEDIES.

This species would yield to the same remedies as advised for the common cabbage looper, namely, Paris green, best applied in the form of a spray, but it is usually not abundant, and hand-picking would suffice on small patches of cabbage or other plants affected.

THE CELERY LOOPER.

(*Plusia simplex* Guen.)

In some portions of our country, as, for example, in Illino s, this species to a certain extent takes the place of the cabbage looper (*Plusia brassicæ* Riley). It is stated to be the commonest species of its genus in Illinois, and is rather generally distributed in the United States east of the Rocky Mountains, from Canada to New Mexico. In most places, however, where it has come under observation it is considerably rarer. It is described by Messrs. Forbes & Hart as a very destructive celery insect, and has been bred by them from sugar beet, and by Mr. Coquillett from lettuce as well as celery. To the latter we are indebted for our principal account of the species.

DESCRIPTIVE.

The moth (fig. 16) is decidedly dissimilar to that of the cabbage looper, having a greater wing expanse, nearly two inches, entirely different coloration, and differently shaped upper wings. These differences are brought out quite distinctly in the accompanying illustration. The lower edges of the fore-wings have a well-defined conical projection. The border is not scalloped, the color is somewhat purplish brown, the darker shades being velvety brown. The silver marks are very distinct, and form the pattern illustrated. The hind-wings are ochreous or yellowish brown, strongly banded with dark fuscous, particularly toward the white border. The ground color of the thorax, fore-wings, and abdomen is duller than that of the hind-wings. The lower surface is pale ochreous, with a rather distinct darker band running through both wings near the middle.



FIG. 16.—*Plusia simplex:* male moth at left, larva at right—somewhat enlarged (original).

The egg is described by Coquillett as milky white, flattened, globular, or turnip-shaped, sometimes with an impressed spot in the center of the upper surface. The upper half of the egg is grooved vertically; the grooves are narrow and the spaces between them roughened. The transverse diameter is about $\frac{1}{60}$ inch.

The larva (fig. 16) is similar to the cabbage looper, and in the examples seen rather more robust posteriorly. The color is very pale yellowish green, and the markings are very similar to those of the cabbage looper, but all of the larvæ examined have the supra-spiracular spots black, which only occasionally happens with the cabbage species. The length is about the same, $1\frac{1}{2}$ inches when fully extended.

The pupa has never been described by comparison with related species. It is in most respects like that of the cabbage looper.

A more detailed description of the moth has been given by Thomas in his fourth report as entomologist of the State of Illinois (9th Report, St. Ent., Ill., pp. 47, 48), which is quoted in Mr. Coquillett's account, which was published in the Eleventh Report of the State Entomologist of Illinois, 1882 (pp. 38–43).

DISTRIBUTION.

The celery looper appears to be a Transition species, but it is frequently taken also in the Upper Austral region, where it breeds in certain localities, particularly westward. Possibly its being more abundant in cold climates will account for the scarcity of reports of injury. Smith reports its occurrence in Hudson Bay territory, Canada; in the United States east of the Rocky Mountains—Colorado at 12,000 feet, and New Mexico; also that it appears throughout the season. Our National Museum collection, with some other sources of information, shows the following list of localities in addition to those that have been mentioned above:

Maine; Massachusetts; Rochester, Rhinebeck, and Poughkeepsie, N. Y.; Washington, D. C.; Westpoint, Nebr.; Caney, Kansas; Merino Valley, New Mexico; Longs Peak, Colo.; Wisconsin; St. Louis, Mo.; Portland and Albina, Oreg. Several of these localities are furnished on authority of Dr. H. G. Dyar. In New York, in the region specified, he captured specimens on different occasions during the last week of July; in Oregon, during the second week of May.

DIVISIONAL RECORD.

There is a single divisional record in regard to the biology of this species. April 10, 1893, we received from Mrs. J. S. Maurice, Caney, Kans., a moth stated to have been observed on blossoms of apple. This had deposited eggs en route, and some larvæ began feeding as soon as received. By May 2 they had nearly completed their growth, and the following day the first larva spun up. As it takes from one to three days for larvæ to transform, and the first moths did not issue till May 20, the pupal stage in this instance may be placed at fifteen or sixteen days. The larval stage during the same period was approximately three weeks. Larvæ fed on weeds with which they were supplied, but as there is no evidence that these were natural foods their names need not be mentioned.

We have no information as to any natural enemy of this species.

REMEDIES.

The same remedies advised for the cabbage looper would, of course, be applicable to this species when it occurs in injurious numbers. It is necessary, however, that whatever remedy is employed be used also on wild food plants, including weeds, which this insect affects.

NOTES ON DIPTEROUS LEAF-MINERS ON CABBAGE.

The leaves of cabbage, radish, and other cruciferous plants are liable to injury from the attack of maggots of the families Drosophilidæ and Oscinidæ. Three species have been identified with such attacks in this country, and a fourth can now be added. It seems probable if the leaves of cruciferous crops in various portions of the country were carefully examined, we might find that several more species have this habit. They are not of themselves particularly destructive, but they contribute their share toward the injury of these plants, different species of cabbage worms being the principal enemies, except in regions where such other pests as the harlequin cabbage bug and the cabbage plant-louse are most numerous.

The Imported Turnip Leaf-miner (*Scaptomyza flaveola* Meig.).—This appears to be the most abundant species, and has received attention by Mr. D. W. Coquillett in an article in Insect Life (Vol. VII, 1895,

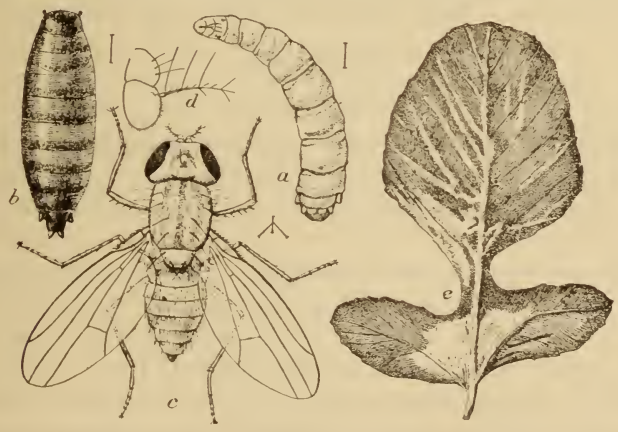


FIG. 17.—*Scaptomyza flaveola*: *a*, larva; *b*, puparium; *c*, adult; *d*, antenna of fly; *e*, work in radish leaf—natural size; all others enlarged (reengraved after Coquillett).

pp. 381–383). Since that publication was issued the writer reared the same species from the leaves of cabbage in the District of Columbia, the adult issuing June 7, 1900. October 4 of the following year the same species was obtained from cabbage at Tennallytown, D. C. It was noticed that the mature flies were quite sluggish in the cool temperature which prevailed at that time. Being interested in this group of insects, the writer obtained from Prof. H. Garman, of the State agricultural experiment station at Lexington, Ky., a specimen of the species which he described and figured on pages 46–51 of Bulletin No. 40 of that station as *Drosophila* sp. This was pronounced by Mr. Coquillett to be the same as that figured in Insect Life, and mentioned under the name of *Drosophila flaveola*. It is illustrated herewith (fig. 17). Mr. Coquillett has since adopted the generic name of Scaptomyza. A short notice is given of this species

by Dr. W. E. Britton (19th An. Rept. Conn. Agr. Expt. Sta. for 1895 [1896], p. 204). He mentions it as a leaf-miner of the cauliflower, and states that some plants growing in the shade were seriously injured, while others finally died.

In looking through the material in the National Museum references have been obtained to rearings of this species which have evidently never been made public. Adults were reared September 9, 1885, from "bolls" of horse-nettle (*Solanum carolinense*)—no locality given, but with little doubt the District of Columbia or vicinity. July 15, 1894, the flies were reared from Iceland poppy (*Papaver medicinale*) received from Mrs. Celia Thaxter, Appledon, Isle of Shoals, off Portsmouth, N. H.; and April 21, 1900, flies were again reared, from the District of Columbia, from larvæ mining the leaves of mouse-ear or thale-cress (*Stenophragma thaliana*), a cruciferous plant naturalized from Europe.

The Native Cabbage Leaf-miner (*Scaptomyza adusta* Loew.).—This was reared with the preceding from the same locality, adults issuing from December 22 to 28. They outnumbered the preceding species three to one, and it is not improbable that this is the most abundant form of dipterous leaf-miner attacking cruciferous crops in the South. We have an earlier record of the rearing of this same species from a growth resembling a gall or fungus on the stems of water lilies, obtained by Mr. Albert Koebele in Virginia, near the District of Columbia, August 24, 1883. The flies issued September 8, and four days later a different species was reared.[a]

We have no very complete knowledge of this insect's distribution. It occurs, however, from Maine to Florida, and westward as far as Illinois. From specimens in the National Museum we have the following localities: Eastport, Me.; Washington, D. C.; Virginia; Biscayne Bay, Fla.; Augusta, Ga.; Algonquin, Ill. The insect was described from the United States, and is evidently indigenous to our soil.

The Imported Cabbage Leaf-miner (*Scaptomyza graminum* Fallen).—This was reared December 22, 1898, from leaves of cabbage received from Augusta, Ga. This is the second rearing of the species from cabbage, the first having been made by Dr. A. D. Hopkins in West Virginia. It is probable that in time this miner will be found to develop in many other plants, since in Europe it is known to attack chickweed, cockle, lamb's quarters, and two genera of catchfly or campian (Viscaria and Silene).

April 5, 1902, Prof. H. A. Morgan, Baton Rouge, La., sent specimens in all stages, with the statement that this species was found with the corn stalk-borer in sugar cane in that vicinity, and the larvæ were confused with the young of the true borer.

In Europe this species is common and widespread, and the same is true of its distribution in this country, although it appears to be

[a] This was determined by Mr. Coquillett as *Crassiseta nigriceps* Loew.

more abundant in the North. Possibly, however, this is only apparent, and it may be found to occur also throughout the South, as it was once taken at Texas College Station by Prof. F. M. Webster on wheat. The distribution taken from specimens in the National Museum includes, besides the District of Columbia and West Virginia, White Mountains, N. H.; Beverly, Mass.; Connecticut; and Detroit, Mich.

It is subject to parasitism, but the species of parasite does not appear to have been identified.

The Native Clover Leaf-miner (*Agromyza diminuta* Walk.).—During the year 1900 this species was several times reared at this office by Mr. Th. Pergande and the writer from larvæ mining the leaves of hedge mustard and smooth rock cress (*Arabis lævigata*) as well as cabbage. The adults issued from the third week in May to the first week in June. The species is treated in the Annual Reports of this Department for 1879 (p. 200) as *Oscinis trifolii*, and 1884 (p. 322) as *O. brassicæ*. The above name is suggested to distinguish it from preceding forms.

REMEDIES.

Nothing of value of a remedial nature has been attempted in the treatment of these leaf-miners, as far as the writer is aware, and it seems improbable that the application of any poisonous mixture would destroy the larvæ at any stage of their growth. Fortunately none of these leaf-miners is, as a rule, very injurious; at least we have no records of injuries to large interests. In small kitchen gardens the insects can be controlled by clipping the infested leaves as soon as the larval mines are found, and destroying them.

It is possible that the flies might be attracted to cans of decomposing turnip or cabbage leaves, slightly sweetened to assist fermentation, and that, if a slight amount of Paris green, arsenic, or other arsenical be dropped in these cans, it would effect the destruction of many flies. Such cans should be distributed about infested fields. The cabbage grower should know by observation when to expect the flies in his vicinity.

THE FOUR-SPOTTED CABBAGE FLEA-BEETLE.

(*Phyllotreta bipustulata* Fab.)

Throughout the summer, from May to September, during the past three years the writer has found this species of flea-beetle, though somewhat sparingly, in the District of Columbia and neighboring parts of Maryland, on cabbage, turnip, hedge mustard (*Sisymbrium officinale*), charlock (*Brassica arvensis*), and shepherd's purse (*Bursa bursa-pastoris*).

Phyllotreta vittata, the striped cabbage flea-beetle, was comparatively rare the first year, and *bipustulata* was apparently more numerous than in former years, which will account for its being noticed on so

many plants. The latter has not previously been recorded, to the writer's knowledge, to occur on any particular plant, although it is not improbable that observing collectors are familiar with its occurrence on Cruciferæ. Its life habits have apparently never been studied, so it is not known whether the larva is a leaf-miner or root-feeder. The beetle appears here at about the same time as the more injurious *vittata*, the first observed date being toward the end of April. Egg deposit has been observed as late as August 4.

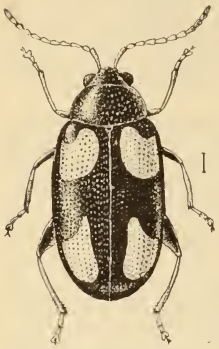


FIG. 18.—*Phyllotreta bipustulata*: beetle—highly magnified (original).

The name above used is suggested for the species.

This flea-beetle (fig. 18) resembles *vittata* but averages slightly larger, and each elytron is ornamented with two large irregularly oval yellow spots, one humeral, the other subapical. The basal 5 joints of the antennæ are paler than the remainder and the legs are more or less rufotestaceous. The above characters will serve to distinguish it from individuals of *vittata* in which the vitta is broken near the middle.

The distribution accorded by Horn (Tr. Am. Ent. Soc., Vol. XVI, 1899, p. 300) is from Pennsylvania to South Carolina. The writer has a series from Ithaca, N. Y., and these localities, together with those from the Hubbard and Schwarz and other collections in the National Museum and a few recorded localities, give the following list:

Lancaster, New York, Ithaca, N. Y.; Camden, Anglesea, Orange Mountains, Fort Lee, Hudson County, and elsewhere in New Jersey; Pennsylvania; Marshall Hall, Md.; Washington and Tennallytown, D. C.; Rosslyn and St. Elmo, Va.; Grand Ledge, Mich.; Marietta, Ohio; Berkeley Springs, W. Va.; central Missouri; Iowa; South Carolina; and Columbus, Tex.

MISCELLANEOUS NOTES ON SOME CABBAGE INSECTS.

The Cabbage Curculio (*Ceutorhynchus rapæ* Gyll.).—This species, an account of which was published in Bulletin 23 (n. s., pp. 39–50), made its appearance in still greater numbers in 1900 than in the previous year, and was found in some localities in abundance where it was scarcely seen on previous occasions.

At Cabin John, Md., all of the cabbage plants examined showed attack by this beetle, one or more individuals being always to be found on each plant. The beetles confined their feeding to the edges of the leaves, as previously noticed. Kale was attacked in about the same proportion, the beetles attacking the pods. Attack was confined to the individuals of the new generation, but the extent of injury could not be estimated. Shepherd's purse (*Bursa bursa-pastoris*) was found on different occasions to harbor the beetles, and it seems probable that this plant and kale serve as food for the larvæ as well as for the beetles.

Dr. Sylvester D. Judd reported to the writer that of six specimens of the rough-winged swallow (*Stelgidopteryx serripennis*) shot at Marshall Hall, Md., July 8, 1898, three had eaten this beetle, as shown by an examination of the contents of their stomachs.

The Seed-stalk Weevil (*Ceutorhynchus quadridens* Panz).—After the publication of the writer's note (Bulletin 23 n. s., p. 51) on the identity of this species with *C. seriesetosus* Dietz., reference was noticed to the same species in Mr. M. V. Slingerland's Bulletin 78, of the Cornell University Agricultural Experiment Station, page 503. The remarks in question form a footnote in the discussion of the cabbage-root maggot, and the statement is made that this weevil is a very serious pest in the great cabbage seed-growing region on Long Island. To make certain of the identity of the species, Mr. Slingerland kindly sent specimens from Nattituck for comparison with named specimens.

Pemphigus sp.—February 14, 1901, Mr. S. A. McHenry, of the Beeville substation of the Texas Experiment Stations, sent specimens of an unknown species of Pemphigus, stating that it was doing injury to the roots of cabbage in the vicinity of Beeville, some of the fields being reported as totally destroyed. One person who furnished material wrote that as soon as the lice attacked the roots of the plants the leaves turned yellow and the plants soon died. He stated that several fine patches had been utterly destroyed.

Wasps as destroyers of cabbage worms.—During July and August, 1900, different species of wasps, and particularly *Polistes pallipes* St. Farg., were observed hovering about worm-eaten cabbage plants in several gardens. In one garden they were always numerous in the western part of a large patch of cabbage. At the extreme eastern end the plants were more or less protected by shade, particularly in the afternoon. At this end larvæ of Plutella, Pionea, and Plusia were at work, but no Pieris, while in the sunshiny places, where the wasps were flying freely, no larvæ at all could be found, although holes in the leaves were evidence that they had been present. The wasps were carefully watched on several occasions, and it was plain from their manner of work that they would first destroy the imported cabbage worms, afterward the loopers, and that the Pioneas would be the last to be captured, as these bored directly into the hearts of the cabbage, concealing themselves between two leaves in such manner that it would be difficult for the wasps to find them in the cursory manner of their search. The Plutellas, owing to their smaller size, might possibly evade discovery.

Singularly, in spite of utmost endeavors, it was impossible to detect a wasp in the act of destroying a cabbage worm, nevertheless circumstantial evidence was so strong that the writer felt no hesitation in attributing the absence of the "worms" in the sunny portion of the garden to the presence of the wasps. The "worms" working on plants

growing in shade were nearly free from wasp attack. The wasps would hover about a plant and then alight and walk about it, but, finding nothing, would continue to the next plant, and so on to another. The following year, in the latter days of August, the writer observed this wasp attacking the larva of *Pieris rapæ*, leisurely chewing it before flying away to provision its nest.

It is evident that this habit of wasps has been observed before. The following was published in Dr. Lintner's third report as State Entomologist of New York, for 1886 (1887, page 135): "Mr. C. R. Moore, of Johnson Town, Va., states that he has seen the common brown wasp (? *Polistes fuscatus*) seize the green worms on cabbage (? *Pieris rapæ*), sting them repeatedly, and then carry them away."

The Cabbage Root Maggot injurious to celery.—Mr. James Granger, Broadalbin, N. Y., mentioned in preceding pages as having reported injury to celery by the carrot rust fly (*Psila rosæ* Fab.), sent, under date of November 19, 1901, a larger larva than that of the rust fly, stating that it occurred in the heart of celery, and that he believed it to be causing "rot." He was aware that the same species, or a similar one, infested radish in the same field, and there is little doubt that this insect spread from the radish to the celery. The cabbage root maggot, as its name implies, attacks cabbage, including all its varieties, as well as most other forms of cruciferous plants. As Mr. Granger has shown himself a good observer by his correspondence, there can be no doubt of his statement that these larvæ occurred in celery. He distinguished the two species, and sent the cabbage maggots in about equal numbers with the rust fly maggots. Celery appears to be a new food plant for the cabbage root maggot. The early rearings were without doubt unnatural, caused by the overheating of the rooms in which the rearing jars were kept.

While there is no doubt that this cabbage maggot is quite closely restricted to cruciferous plants for food, it will occasionally, in case of emergency, attack plants of other botanical orders. Miss Ormerod has quoted Mr. Meade as saying that maggots were reared in 1882 from "earth round partly decayed clover roots," while Lintner has stated on one occasion that the larvæ had been detected mining the leaves of beet (Bul. 78, C. U. Agr. Expt. Sta., 1894, p. 513).

OBSERVATIONS ON INSECTS AFFECTING LATE CABBAGE AND SIMILAR CROPS.

Some attention has been given by the writer in recent years to the study of some of our common insect enemies of cruciferous crops, with a view to ascertaining more in regard to them, and the notes which follow were made to determine just how far careless methods of culture are to blame for injury by these insects. Brief mention has been made in Bulletin 22 (n. s., pp. 55–61) and in Bulletin 30 (n. s.,

pp. 63–75) of the effects of cold and of parasitic attack in limiting the increase of these insects. This work has been continued, with some results which appear to justify the furnishing of more details.

The study of extreme cold and its effect upon insects affecting crucifers was continued until late in December, after which time it usually happens that we have severe freezes which put a practical end to the breeding of most insects. Some species were actually found breeding upon winter cabbage as late as December 24, and this in spite of the fact that, with the exception of perhaps seven days distributed at intervals through November and December, there had been continuous nightly frosts from the time when observations began in the last week of November until their completion. Observations were conducted in the District of Columbia and at near-by points in Maryland. The species under particular observation were five in number. There was no great difference as to the number of individuals or injuriousness. The approximate order, however, was as follows: The cabbage plant-louse (*Aphis brassicæ* Linn.), diamond-back moth (*Plutella cruciferarum* Zell.), harlequin cabbage bug (*Murgantia histrionica* Hahn.), imported cabbage butterfly (*Pieris rapæ* Linn.), and the cabbage looper (*Plusia brassicæ* Riley). Of these the diamond-back moth was the most active, and the looper and the larva of the imported cabbage butterfly the most injurious.

Like many introduced, and Southern forms of insects which have recently migrated northward from the South, these species remain feeding in the field long after most of our strictly native forms, or those which have long been established in the District and vicinity, have sought winter quarters.

The Imported Cabbage Butterfly (*Pieris rapæ* Linn.).—Larvæ were noticed the last week of November feeding with the others which have been mentioned on late cabbage. The work of this species and the cabbage looper was noticeable on all old leaves. Many larvæ were not above half grown at this time, showing that egg deposit had taken place not earlier than the last week of October, and perhaps in early November. Larvæ taken at this time fed freely on cabbage, and most of them attained maturity during the second week of December.

It was quite noticeable that when rains and freezing weather occurred during December, the larvæ crawled deeper into the large heads of cabbage, where they appeared to be abundantly protected.

It was noticed throughout the season, and particularly in late autumn and early winter, that this species was remarkably free from disease as compared with Plusia occurring on the same beds and same cabbage plants, a fact, however, that has been observed by others.

The Diamond-back Moth (*Plutella cruciferarum* Zell.).—In recent years this species has always been found in about the same abundance in spring and summer, but it sometimes occurs, like the other species,

more abundantly late in the year than earlier in the season. During the last week of November larvæ have been seen nearly grown, with about an equal number of pupæ at the same time. Moths captured then deposited eggs even in a quite cold temperature. As with the imported cabbage worm, most larvæ transformed to pupæ during the first week of December. Moths began issuing from this lot December 9.

An interesting feature in connection with the late occurrence of this species was the presence at the same time of one of its most active parasites, an Ichneumonid *Limneria tibiator* Cr. These parasites began issuing the same time as the moths just noted, showing that the enemy has about the same time of appearance in the fall as its host, and perhaps this is the same in the spring. Such coincidence in the time of occurrence of a parasite and its host, however, the writer believes to be rather exceptional.

Moths were seen on a warm day, December 13, flying in the sunshine. This was after three or four days of very cold weather. Nearly every head of cabbage that was touched was found to harbor one or more moths, while others were flying about other vegetation of the vicinity. At no time during the entire year were moths seen in anything like the same abundance as at this time in mid-December. Larvæ and pupæ were also observed.

The Harlequin Cabbage Bug (*Murgantia histrionica* Hahn).—This insect was exposed to the same atmospheric conditions as the preceding species, and was observed feeding with them until late in November. When fields were visited during the middle of December, however, none of the bugs were to be found in exposure upon the plants, although, as has been said, the diamond-back moth was flying freely in the bright sunshine. Under leaves which touched the ground some specimens were found, and such stalks as were pulled up and shaken showed that many of the bugs had crawled in between the leaves into protected places. They were dislodged in some numbers, two score and more being found in single large heads. When the infested cabbage fields were visited a month later it was seen that the more severe frost which had occurred during the month had killed great numbers. By gathering numbers of the bugs and taking them home for counting, an estimate was made that 85 per cent had been killed. Cold spells which followed afterwards doubtless killed many more.

As a result of study of this species for several seasons, it has been ascertained that the bugs do not, as a rule, issue from hibernating quarters until near the end of April. Eggs were first noticed on the 28th of that month, but in some seasons the bugs may lay earlier. The first imagos of the new brood have been observed to develop during the last week of June, the 26th being the first observed date of their development. The second generation usually begins to develop about the beginning of the third week of August.

The wheel bug (*Prionidus cristatus*) was observed attacking the nymphs of this bug on several occasions during June.

The Cabbage Looper (*Plusia brassicæ* Riley).—The observations which were conducted on this species were much the same as for *Pieris rapæ*, with which it was associated. Numerous larvæ were still living in the fields as late as the middle of December. At this time one larva was found less than half grown, showing that the eggs had been deposited about the last week of November.

The Cabbage Plant-louse (*Aphis brassicæ* Linn.).—Of this species it was observed that numerous individuals, but no winged forms, were still present in cabbage fields by the middle of December, mostly, however, in the hearts of cabbage where they had crawled for protection. No parasites or other enemies could be observed at this time.

A number of individuals of this plant-louse were kept in the insectary of this Department in the coolest temperature that could be obtained, the object being to have them furnish food for ladybirds. It was noticed that they survived a temperature of 20° F., which occurred during three successive days in February, and that they were active a few degrees above the freezing point, seeming to be able to fly, since winged individuals were found at the top of rearing cages a foot above the plant on which they had been feeding at a temperature a little below 40° F. Meanwhile the ladybirds, although not dormant, were inactive, responding feebly to stimulation.

CONCLUSIONS.

The practice of planting late cabbage and other crucifers is calculated to be of great benefit to several species of insects, particularly those just mentioned, and the particular reasons are that, as a rule, natural enemies, such as parasites and wasps, and diseases are less active in cool weather, while their hosts are seemingly nearly as active as in warm weather. This, of course, is not really the case; they do not work so many hours in a day, and their growth is slower. The trouble is that the farmer and truck grower generally, at least in those parts of Maryland and Virginia lying near the District of Columbia, appear to think that the insects have disappeared to such an extent that it is not necessary to apply remedies. For the imported cabbage worm, the looper, and the larva of the diamond-back moth, this is the best time to make applications of poisons, as the crops are not needed until a considerable time after poisons are applied, and this does away with any danger of poisoning to human beings. Many individuals of the insects mentioned, without doubt, perish for lack of food, as most wild crucifers are dead at such times.

Such cabbage as is pulled and "heeled in" and covered with underbrush is apt to carry with it many individuals of all of the five cabbage pests under discussion, and when the cabbage heads are covered with

brush this affords a fine shelter against storms and cold. A very large percentage of injury to cabbage in the spring (and this is the time when the principal damage by the imported cabbage worm is done) could be avoided by treating the cabbage freely with Paris green, and the same applies to stalks left in the field for sprouts. Stalks that are not needed for this purpose should be pulled up and burned as rapidly as their uselessness is manifest, and all rubbish should be destroyed in the immediate vicinity of the gardens.

Not alone cabbage, but all other crucifers should be freely poisoned, and if this were practiced over considerable areas the effect the following spring would soon be observable. If plant-lice are found to be at work, kerosene emulsion should also be applied to the crucifers where this would not interfere with their food qualities. Where the cabbage is destined to be soon eaten, pyrethrum, or Persian insect powder, should be applied.

It does not seem that the present methods of growing late crucifers has any appreciable effect upon the development of the harlequin bug, but care should be used not to permit accumulations where the insects can hibernate, and a trap crop of kale should always be left in the field, or planted as early as possible in the spring, and from this trap crop the insects can be collected, or after the main portion of it is taken out for use the remainder can be burned, with the insects which it contains.

In one field recently visited in the latter days of April, a patch of about half an acre of kale was found to be infested rather freely along one side by harlequin bugs. The gardener was advised to burn this side of the patch, using straw to facilitate the operation. This was done, and when the garden was visited two weeks later not a single specimen of the bugs could be found in a walk about this patch. The same was true of the cabbage grown in the same vicinity.

THE SEED-CORN MAGGOT.

(*Phorbia fusciceps* Zett.)

For a number of years economic entomologists in several portions of this country and Canada have had frequent complaints of injuries by a maggot working on young growing beans. More recently this maggot has been found to destroy peas in the same manner.

Considerable doubt has been expressed in some early publications on this insect as to its identity, whether it is the same species as the cabbage root maggot or specifically distinct. This was caused by the fact that both species attack the roots of cabbage, sometimes acting in concert and by the further fact that the group to which these insects belong, two-winged flies of the family Anthomyiidæ, had not been carefully studied. The species under discussion, known by several popular names besides seed-corn maggot, including "bean fly," has

received no less than seven Latin names showing its description that many times as a supposedly new species.

A careful perusal of the notebooks of this office as well as of literature go to show that this maggot is considerably more destructive to beans than to corn, and as many of our Divisional notes have not been recorded they may be mentioned here in connection with reports of injury.

DESCRIPTIVE.

The parent fly of this maggot looks to the casual observer much like a small house fly. It can best be identified by the male (fig. 19, *a*). The principal characteristics of the male consist in a row of short, rigid, bristly hairs of nearly equal length on the inner side of the posterior tibiæ or shanks. The female can scarcely be distinguished

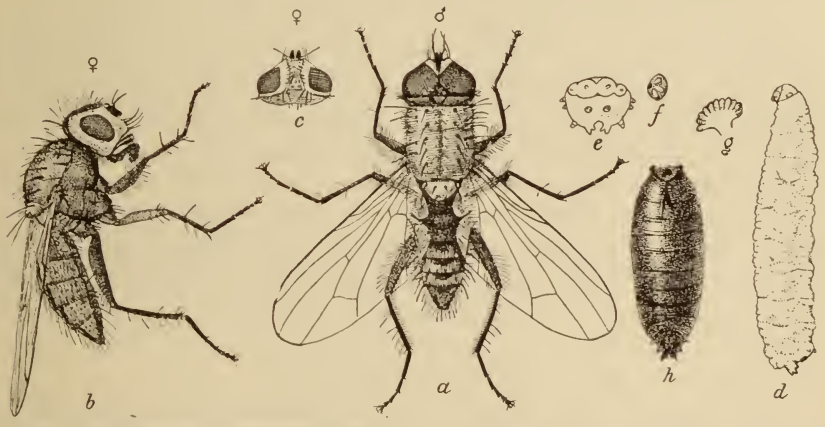


FIG. 19.—*Phorbia fusciceps: a*, male fly, dorsal view; *b*, female, lateral view; *c*, head of female, from above; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, thoracic spiracles; *h*, puparium—all much enlarged (original).

from those of related species, such as the adults of the cabbage root maggot and onion maggot. The length of the body is about one-fifth inch (5^{mm}) and the wing expanse about two-fifths (9.5^{mm}).

The larvæ also resemble the species mentioned. Like other maggots, they are footless and of cylindrical form. As will be seen by illustration 19, *d*, which represents a larva in profile, they are narrowed at the anterior extremity and enlarged posteriorly. They are, however, considerably smaller than the onion maggot, measuring about one-fourth of an inch (6^{mm}) in length and about one-sixth as wide at the thickest portion. Alcoholic specimens are very pale yellow in color, and the chitinous or harder parts at the ends are usually considerably darker. The anal segment is shown at *e*; *f* represents the anal spiracles, and *g* the thoracic ones. There appear to be only 6 or 7 divisions in the cephalic spiracles, whereas in the onion-feeding species there are usually 11 or 12 such divisions.

The puparium (*h*) is barrel-shaped, of elliptical outline, and light brown in color. It measures about three-twentieths of an inch (4^{mm}) and is about one-third that in diameter.

DISTRIBUTION.

The fact of this fly having been described first in Germany in 1845 and of its not having been identified in this country until more than a decade later is indicative of European origin. It appears to have been first recognized in New York State by Dr. Fitch in the year 1856. Like so many other flies, it ranges through several life areas, and we know of its occurrence in Canada and Minnesota, southward to the Gulf, and westward to the Pacific.

The following list of localities has been compiled from published records and from specimens in the National Museum:

Holderness and White Mountains, N. H.; Beverly, Mass.; Greenport, Ithaca, Long Island, Albany (?), and Elmira, N. Y.; Ridgewood, Palisades, Atlantic Highlands, Westville, Jamesburg, and Riverton, N. J.; Travilah, Md.; Washington and Benning, D. C.; Falls Church, Va.; Van Wert County, Ohio; Lexington, Ky.; Tippecanoe County, Ind.; Algonquin and Altamont, Ill.; Grand Rapids, Mich.; Plainfield, Wis.; Park Rapids, Wadena, Alexandria, Camden Place, Rockport, and St. Paul, Minn.; University, N. Dak.; Tabor, Iowa; Nebraska; Hiawatha, Lawrence, and Parsons, Kans.; Eureka, Mo.; South Carolina; Augusta, Meansville, and Atlanta, Ga.; Florida; Auburn and Boligee, Ala.; Mississippi; Shreveport, La.; Rollover and College Station, Tex.; Las Cruces and Beulah, N. Mex.; Salida, Colo.; Los Angeles, Cal.; Ottawa, Ontario, and Chateauguay Basin, Quebec; Lambton County, Aitkens Ferry, and Prince Edward Island, Canada.

RECENT OCCURRENCES.

During 1899 this fly was found in privies and reared sparingly with other insects inhabiting human excrement. (Howard, Proc. Wash. Acad. Sci., Vol. II, p. 584.) January 4 it was reared from cabbage received from Augusta, Ga., and infested also with the imported cabbage webworm (*Hellula undalis*).

March 27 we received specimens of the larva from Mr. F. S. Earle, Auburn, Ala., who wrote that the species was destroying a planting of garden peas at that place, eating out and boring the underground stems of young plants, sometimes destroying the plant before it could get above ground. April 2 he wrote that an entire planting of peas had been destroyed. The previous year he lost many plants of snap beans in much the same manner, attributing the loss to the same species.

June 23 the writer reared a considerable number of the flies from beans in a somewhat novel manner, and one that suggests itself as of considerable utility in rearing root-feeding species. In the course of experiments it was found necessary to place gauze frames over several hills of beans on an experimental plat. These were left in place for a

week, and were fitted tightly to the earth. At the end of this time many flies were found and a number captured for identification.

During the same month Mr. E. E. Ewell, assistant chemist, called the writer's attention to injury to bean stalks grown on the Department grounds, due to the work of a maggot and to other causes. Some were collected and reared to the adult, which proved to be *Phorbia fusciceps*. The fly issued June 11.

November 6 to 15 the species was again reared from cabbage from Meansville, Ga.

In 1900, May 15, we received larvæ from Mr. E. A. Wilson, Rollover, Tex., where they were doing much damage to the roots of cabbage. June 20 we received information of the occurrence of the flies in alarming numbers at Falls Church, Va.

EARLIER DIVISIONAL RECORDS OF INJURY AND OCCURRENCES.

March 5, 1880, we received from Mr. J. S. Newman, Atlanta, Ga., a lot of turnips infested by the maggot of this species.

April 8, 1884, a fly appeared from among a lot of Tineid galls collected by Mr. A. Koebele on poplar at Holderness, N. H.

December 4, 1885, we received from Mr. J. G. Jack, at that time at Chateauguay Basin, Province of Quebec, Canada, specimens of this fly with the statement that the larvæ had been very destructive to beans that summer. This attack will be mentioned more at length under the heading "Literature of the species."

June 7, 1889, we received larvæ from Mr. F. N. Tillinghast, Greenport, N. Y., with the report that the species was doing much damage to the roots of young cabbage.

April 30, 1890, we received from Mr. Clark, Benning, D. C., some young cabbage plants ruined by this maggot.

During 1894 we received, August 6, from Mr. M. V. Slingerland, Ithaca, N. Y., larvæ about which he has published, as will be presently mentioned. Later we received from the same correspondent adults reared from cabbage roots on Long Island. September 14 we received this species in cabbage heads from Mr. L. H. Reed, Grand Rapids, Mich. From this lot the mature flies issued June 14, 18, and 20 of the following year.

June 14, 1895, Mr. Reed sent bean plants showing injury by this species from Plainfield, Wis. (See Ins. Life, Vol. VII, p. 429.) February 5, 1895, we received word from F. A. Young & Co., of New York City, that this species was causing considerable trouble to cabbage crops in South Carolina. It appeared to confine its operations to the stems and roots, and was more plentiful in new land.

LITERATURE OF THE SPECIES.

Dr. Fitch's account of this species is brief. He noticed that the fly occurred in abundance upon the heads of wheat the latter part of June in New York, presumably in the neighborhood of Albany, and as this fly had been currently regarded as the parent of the wheat midge (*Diplosis tritici* Kirby), he gave the insect some attention, and, finding it new to our fauna, described it as the deceiving wheat fly (*Hylemyia deceptiva*) (1st Rept. Ins. N. Y. for 1856, p. 301, Pl. I, fig. 3). Nothing was known by Fitch of the habits of this species further than that the flies hovered over and alighted upon wheat heads at the time when they were in flower. In 1869 Dr. Riley redescribed this species (1st Mo. Rpt., pp. 154–156, Pl. II, fig. 24, text figs. 86 and 87), giving it the name of the seed-corn maggot (*Anthomyia zeas*),[a] also the corn Anthomyia. The maggots were noticed attacking kernels of sprouting corn in the vicinity of Ridgewood, N. J., and in other fields in the same (Bergen) county. Mere mention of the species was made the same year by Riley, and the case is cited here to show the tendency that existed even in those early days, as well as later, to multiply book names for insects. He refers to the species as the "seed-corn flower-fly" (American Ent., Vol. II, p. 137). In 1877 Dr. Riley's third account of this species appears under the title "The Anthomyia egg-parasite" (*Anthomyia angustifrons* Meigen). The statement is made that in the fall of 1876 the maggot destroyed about 10 per cent of locust eggs in Missouri, Kansas, and Nebraska, and in some localities a much larger percentage; it was quite common also in Iowa and Minnesota and occurred in Colorado and Texas (1st Rept. U. S. Ent. Com. for 1877 [1878], pp. 285–289).

During 1885 this species was injurious to beans at Chateauguay, Quebec, Canada (John G. Jack, Can. Ent., Vol. XVIII, p. 22; 17th Ann. Rpt. Ent. Soc. Ont., 1887, p. 17). The beans were planted June 15, and in that part of the field that was most seriously injured at least nine-tenths of the crop was destroyed. Ten days after planting, as few beans had appeared above the surface of the ground, examination was made as to the cause, and it was then found that nearly every bean was infested by from 1 to 25 maggots. Both stems and seed leaves were attacked. By the 28th of June many larvæ had pupated, and scarcely a maggot was found after July 2. The adults issued July 10. Mr. Jack, in reporting this occurrence, stated that "if this bean-feeding habit of the insect should become general, it might prove very annoying."

In Insect Life (Vol. VI, p. 372) Dr. Howard, in referring to parasites of the sugar-beet webworm, makes mention of this species, stating, among other things, that the fly had been reared by Dr. Riley

[a] Spelled on both pages 154 and 155 "*zeas*," without doubt a typographical error.

from the roots of cabbage and radish. It was surmised that the larvæ fed upon beet roots and perhaps crawled into the larval cases of the webworm for pupation. The writer indorses this opinion, and it would seem that beet is to be added as a food plant of this insect.[a] As in previous cases of reported injury, the maggots attacked the plants before they appeared above ground, and were found in the stems after the plant had reached a height of about 2 inches.

In the year 1894 this species did damage to bean plants in Tippecanoe County, Ind., and Van Wert County, Ohio, as reported by Mr. F. M. Webster (Insect Life, Vol. VII, pp. 204–205). Adults were reared June 10 to 18. The nature of attack was as usual with this species.

In the late Dr. Lugger's first annual report as entomologist of Minnesota for 1895 (1896, pp. 111–114, pl. 14, fig. 58), injury to young bean stalks by what is probably this insect is treated, the species receiving mention as the bean-fly (*Anthomyia* sp.). Whole fields of beans, in many places containing many acres, were reported as being completely ruined in the vicinity of Park Rapids, Minn. At Wadena, Minn., injury was also noted. After the seed had been planted about ten days and had not come up, Mr. H. W. Fuller, the correspondent in question, had dug into the hills and found the beans gone. It was not until he had opened several hills that he succeeded in finding the maggots. According to Dr. Lugger, about one-third of the State was more or less infested with this enemy, which was new as regards known injury there. On some farms the insect destroyed nearly all bean plants, while on others farmers were forced to reseed their fields. Another locality specifically mentioned as having suffered losses from this insect was Alexandria, Minn., where about 25 per cent of the crop was destroyed, necessitating replanting.

In 1897 this maggot was concerned in injury to seed-corn at Aitkens Ferry, Prince Edward Island, Canada. The corn was planted June 5 about 3 inches deep, and very little showed above ground. The spring was described as very wet and cold in that locality. This is recorded by Mr. M. V. Slingerland (Rural New Yorker, September 11, 1897, p. 596).

In the year 1900 Prof. W. Lochhead, Guelph, Canada, reported what is also in all probability the seed-corn maggot[b] as injurious during that year in Lambton County, Canada. His note is published under the caption of "The Bean fly (*Anthomyia radicum*)", and he states that in June many complaints reached him regarding the attacks of "grubs" on beans. Hundreds of acres were being destroyed,

[a] Mention is made of the synonymy of this species, but the insect is unfortunately referred to as *Phorbia fuscipes* Zett.

[b] There is very little doubt that the insect which was so injurious in 1895 in Minnesota and in 1900 in Canada was *Phorbia fusciceps*, but specimens are not available, hence the identification can not be positively made at present.

many beans did not germinate at all, owing to the fact that the maggot ate the interior of the seed, while many stems failed to develop through the destruction of the central portion of them. Professor Lochhead was of the opinion that injury might have been due to deep planting. The note in question, 31st Rept. Ent. Soc. Ont. for 1900 (1901, p. 73), was illustrated with a figure adapted from Dr. Lugger's.

A review of the known history of this species was given by Dr. Lintner in 1882 (1st Rpt. Ins. N. Y., pp. 181–184), and later, in 1894, Mr. Slingerland gave a similar review (Bul. 78, Cor. Univ. Agr. Exp. Sta., 1894, pp. 499–501). Dr. Forbes also published an account in 1894 (18th Rpt. St. Ent. Ill. for 1891 and 1892, pp. 16–19), which includes a few notes on occurrences in the seed of corn and dates of rearing, and detailed descriptions of the larva, puparium, and imago, with original illustrations. Some shorter accounts have been published that add little to our knowledge of this seed maggot.

Although this insect is not restricted to either corn or beans, it seems to the writer that the name "seed-corn maggot," bestowed upon it years ago by Dr. Riley, may be retained in preference to "Fringed Anthomyiian," which has recently been proposed. It has priority, and the latter name would not be apt to be adopted by the average person engaged in agriculture.

The following are among the synonyms of *Phorbia fusciceps* Zett.:

Aricia fusciceps Zett., 1845; *Hylemyia deceptiva* Fitch, 1856; *Chortophila cilicrura* Rond., 1866; *Anthomyia zeæ* Riley, 1869; *Anthomyia radicum* var. *calopteni* Riley, 1877; *Anthomyia angustifrons* Meigen, 1878; *Phorbia cilicrura* Rond (Meade), 1883.

SUMMARY OF FOOD HABITS.

From what has been related of the habits of this species it will be seen that real injury is practically confined to planted seeds and very young sprouting plants, particularly of Indian corn and beans of different kinds. When young plants of bean, corn, and cabbage are not available it will attack other plants, and future study will undoubtedly show that it has a wide range of these. Peas are attacked in the same manner, but this does not appear to have previously been recorded. It may be, from the fact of Fitch finding the flies so abundantly in wheat fields, that the insect also attacks sprouting wheat, as the fact that injury has not been detected is no indication that attack is not made. There is little doubt that beets are attacked. Turnips and radish are known to be infested, and it seems more than probable that the insect may feed on decaying vegetable and perhaps animal matter, as the larvæ are so frequently found on such portions of plants as have first been attacked by other insects. The rearing of the fly from galls on poplar, previously mentioned, is an unusual indication of the last-mentioned habit. Dr. Riley's account of the species having been beneficial upward of a quarter of a century ago by feeding upon locust

eggs should not be overlooked. It does not necessarily show more than an occasional carnivorous habit, as the attack under consideration occurred during extreme abundance of the locusts. The onion has been recorded as a food plant in England, seed potatoes have been attacked, according to Lintner, and hedge mustard has been recorded as a food plant by Slingerland.

LIFE HISTORY.

The life economy of the seed-corn maggot is very imperfectly understood. In spite of the many writings on this insect the species has evidently never been under continuous observation in any locality, and what has been published affords evidence only of a single generation. It has been surmised that the species agrees with others of its kind in passing the winter in the adult condition, although it is possible also that it hibernates, in some localities at least, as a puparium. Of one thing we may be tolerably certain, that only a single generation is developed in corn, but it is quite probable that two generations might be produced in beans and peas owing to the longer period in which these crops are kept in the field, and the second and third plantings that are made in many localities. In the Gulf States the flies have been reared as early as January 4, and the rearing notes which have been cited for that region show that the flies may appear through the first three months of the year. The fact that larvæ were received from Texas in the middle of May would indicate a second generation in the South, the progeny of the flies appearing in the earlier months. Flies have been reared also in or from different localities in June, July, August, September, and December, and it seems probable that where weather conditions favor, several generations are normally produced each year, although there must be a period in midwinter in which breeding ceases, and possibly another in midsummer.

Professor Forbes has admitted the probability that later generations might appear than that observed by him on corn, the adults from which emerged from June 11 to August 7. In the Northern States it is probable that we have at least two generations, the first injurious in May and June to such seedlings as are then to be found, and the second generation feeding upon weeds or dead or dying plants, in excrement and in refuse, without their presence being manifested.

It would be interesting to learn if most of the injuries occasioned by the seed-corn maggot are not due to the attraction of the winged fly for oviposition on manure used in the field or to the decomposition of a portion of the seeds (something which must always happen) or to the presence of other decomposing material, due to natural causes, to fungus attack, or to infestation by primary pests.

NATURAL ENEMIES.

The seed-corn maggot undoubtedly has many insect enemies, but none appear to have been recorded.

June 21, 1897, we received from Mr. E. F. Bouchville, Boligee, Ala., a large number of flies of this species with their bodies distended by a white powdery growth caused by the presence of a fungus disease, identified at the time as *Empusa americana*. It belongs to the same genus as the house-fly parasite (*Empusa muscæ*).

Frequently the latter disease causes much mortality among flies living out-of-doors, as happened during the summer of 1891. (See note by C. L. Marlatt in Insect Life, Vol. IV, pp. 152, 153.)

REMEDIES.

Owing to the great difficulty of destroying subterranean larvæ and the cost of the chemicals that are used for this purpose, such as bisulphid of carbon, we have to depend more upon methods of prevention. One of the best means of deterring the parent flies from depositing their eggs consists in sand soaked in kerosene—one cupful to a bucket of dry sand—placed at the base of the plants, along the rows. This also kills young larvæ that might attempt to work through the mixture.

Fertilizers, preferably kainit and nitrate of soda, are also useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. They should be applied as nearly as possible to the roots, and the earth should be turned away from the plants for this purpose. This remedy has the advantage of acting as a fertilizer as well as a preventive of insect attack.

As soon as plants show signs of wilting, and this maggot is known to be present in the field, the injured plants should be promptly pulled and destroyed.

The above methods of control have been used with success against onion maggots and similar root-feeding species.

THE BEAN LEAF-ROLLER.

(*Eudamus proteus* Linn.)

In October, 1901, Mr. William R. Polk, Orlando, Fla., complained of what he described as a green leaf-roller on snap beans. No specimens were received at the time, but the adult insect was identified by our correspondent as being the indirect cause of the injury. At the time of writing he stated that it had been busy laying eggs, and the leaf-roller or leaf-curler worm, as it was also called, was "destroying much of his beans by cutting and curling the leaves." November 12 our correspondent sent specimens of the butterfly as well as larvæ in different stages of growth.

The same month we received by request from Prof. H. A. Gossard, Lake City, Fla., specimens of the larva of this species found on cowpea, with the accompanying information that two hours' search in a patch of velvet beans failed to find any of these caterpillars. Mr. Gossard was not certain that velvet beans were exempt from attack, but it is evident that they must be comparatively so.

DESCRIPTIVE.

The butterfly.—This leaf-roller is the larva of a butterfly called the "swallow-tailed skipper," and is quite unique among garden pests. The butterfly is illustrated in figure 20, *a*. It has a robust body and wide head, and the antennæ are curved at the tips as figured. Its color



FIG. 20.—*Eudamus proteus: a*, butterfly; *b*, larva, dorsal view; *c*, larva, lateral view; *d*, chrysalis in rolled-up leaf—somewhat enlarged (original).

is velvety brown, with long metallic-green hairs on the thorax and contiguous parts of both pairs of wings. The fore-wings are ornamented with white spots and the hind-wings are bordered with a zigzag line of white; the latter terminate in two long, dark-brown tails. The wing expanse is from $1\frac{3}{4}$ to 2 inches. The lower surface is much paler brown, with broad bands of darker brown.

The egg is nearly spherical, depressed below, and marked with ridges, converging at the polls. The eggs when first deposited are glistening white, but soon become yellow. They measure nearly a millimeter in diameter and about 0.8^{mm} in length.

The larva is of the peculiar appearance shown in the illustration (*b*, *c*), nearly cylindrical, with narrow neck and prominent head. The

ground color is yellow, dotted with black, and the surface is covered with numerous short, pale hairs. The head is black, with orange spots near the mandibles, and the apical third is reddish. The thoracic plate is also black. It measures, when full grown, about $1\frac{1}{5}$ inches.

The pupa (fig. 20, *d*) is shining brown, the eyes brownish-black. Two or three days after being formed the pupa becomes covered with a peculiar white flocculent coating. Its length is about seven-eighths of an inch.

DISTRIBUTION.

This species is tropical, and apparently injurious only in Florida, although it is recorded to occur in South Carolina, Georgia, and southern Texas. Along the Atlantic seaboard it sometimes extends, probably only by flight of the adults, to a considerable distance north, individuals having been captured in New York City and about New Haven, Conn. It is probably not possible for the insect to breed in the Northern localities. It does not appear to be found very far inland.

As to the foreign distribution of this species Scudder has not indicated special localities with the exception of Mexico. Through the kindness of Dr. Dyar the following localities, based mainly upon material in the National Museum, may be added: Cuba, Jamaica, Trinidad, Guatemala, Venezuela, Buenos Ayres, Argentina, and Paraguay.

GENERAL REMARKS ON BIBLIOGRAPHY AND HABITS.

For many years this caterpillar, known as the bean leaf-roller or "roller worm" (*Eudamus proteus* Linn.), has been recognized as an enemy to leguminous and some other crops in the Gulf States. Injury is usually confined to beans and to cultivated beggar weed (*Desmodium tortuosum*); but according to Prof. J. H. Comstock, who gave an account of this insect in 1880 (Annual Report U. S. Dept. Agr. for 1880, p. 269), cabbage and turnip may also be affected. The article cited has long been out of print, and as the species has not received any attention, or been figured in any later publication of this Department, the opportunity is taken to present illustrations of the insect in all its stages, together with such brief descriptions as are necessary for identification, to which is added a summary of the life habits. For the benefit of anyone who desires to go more deeply into the subject, it might be added that an extensive account of this species, with illustrations and bibliography up to 1889, may be found in Volume II of Dr. S. H. Scudder's Butterflies of the Eastern United States and Canada, pp. 1386–1393. A more recent account has been given by Mr. A. L. Quaintance (Bul. 45, Fla. Agr. Expt. Sta., 1898, pp. 55–60).

NOTES ON DIVISIONAL RECORDS.

Our Divisional records of injury by this species, including the reported damage by Professor Comstock, comprise the following:

February 5, 1880, at Rock Ledge (Brevard County) and Enterprise, Fla., it was destructive to beans, turnip, cabbage, etc. The larva was generally known by gardeners as the roller worm. February 21 larvæ were received which were found feeding upon the cowpea growing wild along the banks of the St. John's River at De Land Landing, Fla. November 4, 1881, larvæ were received from Mr. J. C. Neal, Archer, Fla., where they were destructive to *Desmodium* (*Meibomia*) *canescens*. December 2, 1895, we received from Mr. C. K. Babbitt, Lakeville, Fla., larvæ found feeding on bean and cowpea.

An individual of this species kept at Washington in confinement in a moderately heated room (60 to 70° F.) transformed to pupa October 30, and it was noticed that the pruinosity appeared the next day, increasing in intensity for two or three days. The butterfly matured December 15, the individual having passed six weeks in the pupal condition. In its exit from the chrysalis it left the skin nearly intact.

HABITS AND LIFE HISTORY.

A few plants other than those mentioned serve as food for the larva; these include different species of Wistaria and Clitoria. Frequently larvæ are so abundant as to nearly destroy otherwise promising fields of beans.

According to the observations of Mr. Quaintance (l. c.) the first generation appears in early spring, and successive generations continue until cool weather. In the extreme south of Florida, however, development may be nearly continuous throughout the year, as larvæ have been noticed there during the last of December and in January. In the heat of summer the life cycle is short, requiring, in some cases, only twenty-four days from the deposition of the eggs until the emergence of the adult. The eggs may hatch in four days, the larvæ go through their five molts, and in two weeks from the time of hatching have been noted to enter the pupal state, the latter stage requiring a period of six days. In colder weather in October and November the life cycle may require as long as 37 days. It is probable that the species hibernates as pupæ.

Eggs are deposited on the lower surface of leaflets of bean in groups of from one to six. After feeding a short time the larva prepares a retreat by folding over a flap of a leaf. From this shelter the larvæ crawl out sometimes 6 or 7 inches, and feed upon the surrounding foliage. This species does not differ from other butterflies in being diurnal in habit, larvæ and adults moving about freely at all times of day.

REMEDIES.

Paris green has been used with success by Mr. Quaintance in the treatment of this species on beans in Florida, applied at the rate of a pound to 150 gallons of water, which is sufficiently strong to destroy the larvæ. Quicklime should always be added, in the preparation of this spray, as it neutralizes the arsenious acids which might otherwise be produced when rain follows the spraying. Equal amounts of lime and Paris green are the proportions. Arsenate of lead would probably be more satisfactory, because not apt to scald the foliage.

THE PEA MOTH.

(*Semasia nigricana* Steph.)

In New Brunswick, Nova Scotia, and Ontario, in the Dominion of Canada, where pea-growing is an important industry, there is, in addition to the pea weevil discussed in previous pages, a seed-infesting insect known as the pea moth, the larva of which develops in ripening peas in the pods. This species first attracted attention near Toronto, Ontario, in the year 1893, and since that time yearly complaints have been made of its ravages.

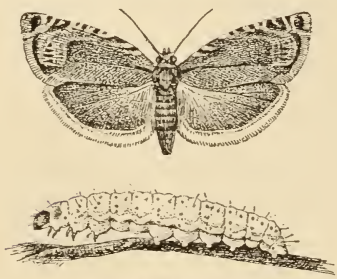


FIG. 21.—*Semasia nigricana* Steph.: moth above, larva below—about three times natural size (original).

DESCRIPTION.

The moth is a small Tortricid, with a wing expanse of half an inch. The fore-wings are dark fuscous or dusky, tinged with darker brown and mottled with white, about as shown in figure 21. The hind-wings are nearly uniform, dark fuscous, and bear a rather long fringe with an inner line.

The larva, shown also in figure 21, is whitish-yellow with pale brown head and thoracic shield, the latter inconspicuous. Its length when mature is about the same as the wing expanse of the moth. The tubercular spots are also inconspicuous, and the hairs are short and sparse.

The pupa does not appear to have been described.

DISTRIBUTION.

This is a comparatively new importation from the Old World, where it has been known for many years as an enemy of the pea. It does not appear to affect any other plant, and injuries are most notable on late crops. It is practically unknown in the United States, but since it is an imported species, there are the best of reasons to believe that it will in time invade New England, New York, and other Northern States, and pea growers should be warned against it.

NOMENCLATURE.

Considerable confusion might be caused if one did not have at hand a rather full literature bearing upon the classification of the pea moth. In a catalogue of Lepidoptera issued by Staudinger & Wocke in 1871, two species are placed in the genus Grapholitha, the pea moth being represented by *nebritana* Tr., with *nigricana* Steph., and *pisana* Gn. as synonyms. There is also a *nigricana* H-S. In Meyrick's handbook of British Lepidoptera, published in 1895, the pea moth is placed in the genus Laspeyresia, *proximana* Walk. being indicated as a synonym, while our other species is listed as *Epiblema nigricana* H-S. This latter is stated to breed in the buds of *Pinus picea*. It is shown herewith for comparison with the true pea moth (see fig. 22).

HISTORY AND HABITS.

It is somewhat singular, considering the time that this species must have been present in America in order to be destructive as early as 1893, that it has not occasioned losses also in our Northern States. Even as early as the date mentioned it was stated to be the principal obstacle encountered in the cultivation of the pea in Canada, the attack frequently resulting in destroying the usefulness of from 10 to 20 per cent of the crop.



FIG. 22.—*Epiblema nigricana* H-S: moth, about three times natural size (original).

The full life history of this species has not been studied. It is known that the moths fly about sometimes in large numbers around pea blossoms a short time after sunset. The females lay from 1 to 3 eggs on very young pods or ovaries. The caterpillar, according to observations in Europe, is hatched in fourteen days, and goes into the pod and attacks the seed, the opening made in the margin of the pod closing afterwards. Pods thus affected usually ripen early. When the pod opens the mature caterpillar creeps out and enters the earth, there to spin a cocoon-like covering formed of silken threads. Authorities differ as to the state of hibernation. Miss Ormerod (Manual of Injurious Insects, p. 163) states that the larva winters over, and in spring turns to a chrysalis, the moth appearing in June, while Dr. J. Ritzema Bos, in his work on Agricultural Zoology (London, 1894), says that "the pupæ live through the winter." The peas attacked are always covered while in the pod with the cross-grained excrement of the caterpillars, and frequently two or three are joined together by web fibers.

Recently it has been ascertained that the pea moth larva does not injure to any extent the earliest and latest varieties of peas.

REMEDIES.

What has just been said indicates the value of planting the earliest and the latest varieties of peas, and this will probably hold as a good remedy in many localities where the species occurs injuriously. Mr. W. T. Macoun has named Alaska, American Wonder, Gregory's Surprise, Gradus, Nott's Excelsior, and McLean's Little Gem as among the best early varieties. The first three mature as early as June 17, before the appearance of the moths. Crops grown for seed are more difficult to protect.

It has already been advised that clean culture would be found a valuable means of riddance of this insect, and if during the picking the plants are found to have been infested, as soon as the crop is off the remnants should be gathered and burned.

Early fall plowing has also been recommended, but it does not seem that this is necessary if the fields are burned over promptly. In Dr. Fletcher's report for 1900 (1901, p. 214), the results of some experiments that were made in New Brunswick are given. They consist in the use of a spray of Paris green, 1 pound to 100 gallons, with 4 pounds whale-oil soap added, in order that the mixture shall adhere to the waxy pod of the pea. The results were so promising as to show them of importance. Three sprayings are suggested: the first to be applied when the blossoms begin to fall, the second a week later, and the third ten days later than that.

THE BEAN CUTWORM.

(*Ogdoconta cinereola* Guen.)

A caterpillar which has been called the bean cutworm does injury to the foliage and pods of beans, at times stripping the vines bare. The species has long been known to collectors of Lepidoptera, but although widely distributed little has been published concerning its habits, although all of its stages except the egg have been described. It appears to be recorded as doing injury only in the States of Florida and Mississippi.

DESCRIPTIVE.

This species belongs to the family Noctuidæ, or owlet moths, which includes many cutworms, but it is not related to any of the true cutworms, and has never been observed, so far as the writer knows, to be nocturnal or to cut tender plants. Hence it is probable that it is not a cutworm at all and the above name is a misnomer. It is more closely related to the cabbage looper and similar forms.

The moth is a tolerably well-marked species, having a wing expanse of a little over an inch, the fore-wings being light brown and marked with a transverse paler band on the outer third. The reniform mark is distinct, as are other similar markings between that spot and the

thorax. The pattern is about as shown in fig. 23, *a*. The hind-wings are nearly uniform gray, with the veins showing plainly and the base of the cilia also well defined. The under surface is nearly uniform grayish-brown, like the hind-wings, but with a more satiny luster.

The larva (*b*) when full grown resembles rather strongly a small cabbage looper (*Plusia brassicæ*), and when disturbed has the same habit of looping like a geometer. It is pale green with three moderately distinct white stripes—median, lateral, and one midway between these two. The length when full grown is about an inch or a little over.

The pupa is shining, rather pale brown, and strongly and deeply punctured on the dorsal surface. It measures about four-tenths of an inch.

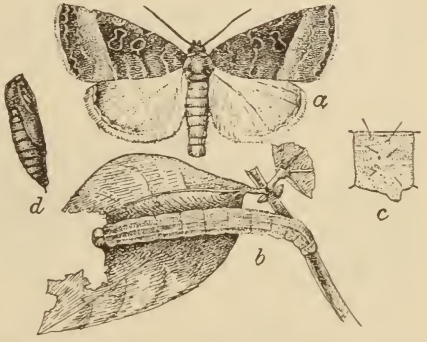


FIG. 23.—*Ogdoconta cinereola: a*, moth; *b*, larva; *c*, abdominal segments of larva; *d*, pupa—all enlarged (original).

DISTRIBUTION.

This Noctuid is generally distributed over the United States east of the Rocky Mountain region, from Canada and Minnesota southward to the Gulf States and the West Indies. It is recorded or is known from New York, Delaware, Virginia, District of Columbia, Florida, Mississippi, Texas, Kansas, Nebraska, and Illinois.

Professor Snow has reported it common in Kansas. In Florida, according to Mr. Ashmead, it is rare, and from what can be learned it seems probable that with the exception of a few States, like Mississippi and Kansas, where it has been found abundant, it is not particularly common.

HISTORY AND LITERATURE.

Until quite recently this species was known to collectors and in literature as *Telesilla cinereola*. It was first described by Guenée in 1852 (Spec. Gen. Noct., Vol. II, p. 316) under the genus Placodes. In 1880 Mr. D. W. Coquillett published a description of the larva observed at Woodstock, Ill., with the remark that larvæ were found in a wheat field from June 15 to July 20, but that the food plant was unknown. Transformations were observed to be made under ground. (No. Amer. Ent., Vol. I, p. 52.) The following year Mr. Coquillett again described this larva (10th Rept. St. Ent. Ill., 1881, p, 180), adding the ragweed (*Ambrosia artemisiæfolia*) as a larval food plant. In 1887 Mr. W. H. Ashmead made a more detailed description of the larva and a brief one of the pupa, adding that the larvæ feed on the leaves

and pods of bean, sometimes stripping the vines bare. (Bul. 14, Div. Ent., U. S. Dept. of Agr., pp. 21, 22.) In 1890 a brief note by Mr. G. H. Kent, Roxie, Miss., was published in Insect Life (Vol. II, p. 283), in which the statement was made that this larva was feeding on bean pods, doing considerable damage to the crop.

UNPUBLISHED DIVISIONAL RECORDS.

October 7, 1883, Mr. Albert Koebele, then of this office, found in Virginia, near the District of Columbia, several larvæ feeding on cocklebur (*Xanthium strumarium*). They were on the under sides of the leaves, and when at rest were stretched generally on the midrib and some of the larger ones on the stems of the leaves. November 7 oblong cocoons were found in the earth, of which they were formed. The moths from this lot issued in confinement June 3 of the following year. September 3, 1885, Mr. Th. Pergande found larvæ in the District of Columbia feeding on sunflower (Helianthus). Moths from this lot issued in confinement the following year, May 10, 11, and 13. It does not seem probable that this species is limited to the bean among cultivated plants for food. On the contrary, it may now be, or may develop into, a somewhat general feeder, as it has been shown that it breeds normally upon composite plants, such as ragweed, cocklebur, and sunflower.

No parasitic or predaceous enemies appear to have been recorded.

REMEDIES.

An arsenical spray, preferably of arsenate of lead, would kill this insect when it occurs in numbers on beans, but care should be used when it attacks the pods, if these are soon to be used for food, to guard against possible poisoning of human beings. The destruction of the insect upon its wild food plants, such as pigweed and cocklebur, is also advisable, and it would be well to keep these plants down in regions where the bean cutworm has once been injurious.

NOTES ON INSECTS AFFECTING BEANS AND PEAS.

Under the above title the writer has brought together certain short notes on different species of insects that have either been treated in a popular or general manner in earlier publications, or that have not yet been made the subject of special study during recent years. All that will be mentioned have come under observations through their occurrence on beans, peas, cowpea, and related legumes, and have been actually detected feeding upon one or more of these plants. Certain of the data that have been acquired concerning this class of insects have been made public in an article which took the form of condensed and popularized accounts of the more common and injurious forms. This

was published in the Yearbook of this Department for 1898 (pp. 233–260), and is also issued in popular form. Other articles and notes have appeared in Bulletins 8, 9, 19, and 23 of the present series, or are included in previous pages of the present bulletin. The notes which follow have been made since the publication of certain of the articles and notes referred to, or were necessarily excluded for lack of space or as inappropriate to a popular consideration of the subject. The facts at hand are not deemed of sufficient importance of themselves to justify more complete treatment at the present time.

The Gray Hair-streak Butterfly (*Uranotes* [*Thecla*] *melinus* Hbn.).—Among other garden insects observed by Mr. A. N. Caudell upon the occasion of his collecting trip in Colorado during the summer of 1901 was the caterpillar of this pretty butterfly, feeding on the pods of Windsor bean, in the garden of Mr. E. J. Oslar, at Denver. Normally they live in that region on *Astragalus mollissimus* Torr., a leguminous and, it might be added, pestiferous plant, growing on prairie land and commonly known as "loco weed."

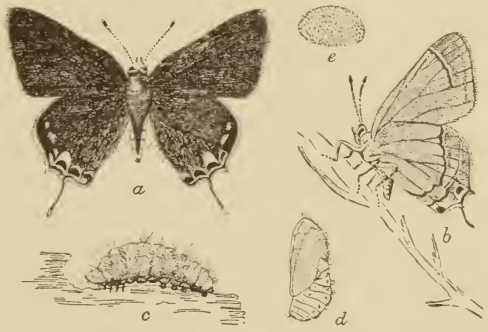


FIG. 24.—*Uranotes melinus*: *a*, dorsal view of butterfly; *b*, butterfly, with wings closed; *c*, larva from side; *d*, pupa; *e*, egg—all somewhat enlarged, except *e*, greatly enlarged (all except *e* redrawn from Howard).

During the last four years this species has been under observation as an enemy of beans. In fact, the bean, although not perhaps a special food plant, appears to be attacked every year by this insect, although injury is not as a rule severe.

In 1897 Prof. W. G. Johnson observed it on bean in Maryland (Bul. 9, n. s., Div. Ent., p. 83).

The next year the writer observed the larva on hog peanut (*Falcata* [*Amphicarpæa*] *monoica*) and tick trefoil (*Meibomia* spp.). The resemblance of the larva to the pods of the last-mentioned plant is striking. A number of other wild food plants are recorded, including among the legumes, bush-clover (Lespedeza).

July 8, 1899, numerous moths were noticed by the writer at Cabin John, Md., between rows of Lima beans, late in the afternoon, hovering about and alighting upon the blossoms. Some were captured for identification, but further observations were not made. During the same month and year larvæ were observed working on pea pods and devouring the peas at Carthagenia and Wooster, Ohio, and in the silk of corn at Clifford, Ohio (Webster, 30th An. Rept. Ent. Soc. Ont., pp. 56, 57, 1900).

Attack by this species to pole Lima beans at St. Elmo, Va., was reported by Mr. Pratt, August 27 and later in 1900. It seems that even a single boring in a pod of beans is enough to insure injury. He estimated that about 25 per cent of the crop of that vicinity was damaged.

An illustrated account of this insect, entitled "The gray hair-streak butterfly and its damage to beans" was published in Insect Life (Vol. VII, pp. 354, 355).

It is illustrated in its various stages in the accompanying figure 24.

A natural enemy of this insect has been observed in a small ichneumon fly *Anomalon pseudargiole* How.

This species seldom does very severe damage, hence little precaution need be observed in the treatment of it early in the season. It would be well, however, to destroy all affected bean pods, that the insect may not develop and do injury in after years.

The Bean Leaf-beetle (*Cerotoma trifurcata* Forst.)—This insect has already been reported by Professor Johnson in Bulletin No. 26 (n. s., p. 81) as having been very destructive in 1900 to wax and Lima beans throughout the trucking area of Maryland.

May 14, of the same year, the writer found this species at work on bean at Cabin John, Md., doing, it would seem, the greatest damage ever observed in the East. Not a single leaf had escaped its ravages; all were pitted full of large holes or had been stripped to the midrib.

The following day Mr. Henry Olds, of this Department, reported this insect injuring bean at Woodside, Md., and Mr. Pratt noticed the same insect at work on beans at St. Elmo, Va.

May 26, Mr. B. M. Hampton sent specimens from Peacocks Store, N. C., with report that this beetle was known locally as the "terrapin bug" (a name which it shares with *Murgantia histrionica*), and that it was a perfect nuisance, doing much injury to snap beans by eating holes in the leaves.

A second visit was made to the infested garden at Cabin John June 12, a month after infestation was first noticed. The rows of beans that had been first planted and that were noticed to be most injured were practically ruined. They had not made such good growth as other rows planted later, and many of the leaves had dried up and fallen off. The later rows, though they had made better growth, looked, as an observer remarked, "as though they had been shot full of holes from a shotgun."

The Lima-bean Vine-borer (*Monoptilota nubilella* Hulst.).—This species, an account of which was given by the writer on pages 9–17 of Bulletin No. 23, n. s., made its appearance the past year on Lima beans, and in a new locality. August 27, 1900, Mr. Pratt reported the larvæ at work on pole Lima beans at St. Elmo, Va., and late in September found that the same species was working on bush

Lima beans—something that it was not observed to do in previous seasons.

October 8, he made examination of different plants growing in his own garden and reported that at least 50 per cent of the galls examined showed that the occupants had escaped. From observations made at this time he concludes that this vine borer is capable of doing severe damage, the part of the stem above the galls seldom producing beans, and in some cases dying. Injury, however, is not readily apparent owing to the fact that from 4 to 6 plants often grow on one pole and injured portions are usually concealed by the numerous leaves. In one instance no less than 17 galls were counted on a single plant, while the other plants in the same hill were scarcely affected. In another instance galls were observed at the roots of the plants on a level with the soil, the gallery extending an inch below the surface.

At Cabin John, Md., where this species occurred in 1898 and 1899, it reappeared, but in much diminished numbers.

After the publication of the writer's article, previously cited, Dr. Hopkins's note entitled "A Lima bean borer" was remembered, too late, however, for insertion in the bulletin mentioned. This note appeared in Volume VII of Insect Life (p. 146.) As the publication mentioned is not available to everyone, his note may be repeated here:

> September 8, a Lepidopterous larva was found causing considerable damage to Lima-bean vines in Wood County, W. Va. The larva was about one inch long, the body uniform purple above and light blue beneath. It occupied about two inches of the vine, causing a swelling or kind of gall, in this respect resembling the habits of the common stalk borer (*Gortyna nitela*). When more than one larva occurred in a plant it died from the injury. I also failed to rear the adult of this insect.

Dr. Hopkins's as well as the writer feels little hesitancy in stating that this is the same species, *Monoptilota nubilella* Hulst.

A new natural enemy of this insect was observed by Mr. Pratt at St. Elmo, Va., the larva of a species of soldier beetle, either *Chauliognathus pennsylvanicus* or *Ch. marginatus*. This larva was detected in the act of devouring a vine-borer larva, and several dead larvæ of the moth and of the soldier beetle were found in the galls.

Diabrotica atripennis Say.—July 10, 1899, the adults of this species were observed by Mr. Pratt attacking the blossoms of Lima beans at Travilah, Md. Specimens brought to this office continued feeding on bean blossoms in confinement. This is the first observation of the food habits of this species of which the writer has knowledge. The larval habits are unknown, but larvæ doubtless feed about the roots of some wild leguminous plant in the same manner as *Diabrotica vittata* feeds upon cucurbits and *12-punctata* at the roots of cereals.

The Mexican Bean Weevil (*Spermophagus pectoralis* Shp.).—Under date of July 26, 1900, Mr. Enrique R. Margarit, Habana, Cuba, transmitted

specimens of black beans infested by this species, present in all stages at the time of receipt, August 1. Our correspondent stated that these beans were raised in Mexico, in hot regions, and immediately after harvest were taken to cold regions, where the seed was kept for a long time, sometimes even for two years, but as a result of being in Cuba even ten days seed commenced to show evidences of attack and soon destruction was complete. In winter this seed keeps in Cuba about thirty days. The same happens to black beans harvested in Cuba.

The species does not appear to have been previously recorded from the West Indies.

From the material obtained and kept under observation it is now positive that this species has practically the same life habits as the other pea and bean weevils, accounts of which the writer has given in the Yearbook of this Department for 1898 (pp. 234–248).

The Pea Weevil (*Bruchus pisorum* Linn.).—So far as known to the writer, no parasite of the pea weevil has been recorded. A single species of the family Chalcididæ, however, *Bruchobius laticollis* Ashm. MSS., was reared from peas infested exclusively by this weevil and received in October, 1898, from Fayetteville, Ark. This parasite is much more abundant on other species of Bruchus which affect bean and pea, our two bean weevils and the cowpea weevil.

The Boll Worm, or Corn-ear Worm (*Heliothis armiger* Hbn.).—This species, after a year of comparative rarity in Virginia, Maryland, the District of Columbia, and northward, became quite numerous during the year 1900, particularly toward the close of the season, doing con isderable damage to late corn and some other crops, including Lima bean, the seeds of which it devoured. During 1899 also we received this insect with reports of its having been found on what appear to be new food plants, as follows: October 21, 1899, the larva was found boring into the stems of peanut by Mr. T. I. Todd, Athens, Ga.; June 14, 1900, Mr. F. S. Earle, Auburn, Ala., reported this larva to be eating into and destroying seeds in the pods of hairy vetch (*Vicia villosa*); October 15, larvæ were found by Mr. F. C. Pratt in considerable numbers in an experimental plat of chick-pea or gram (*Cicer arietinum*) on the Potomac flats near the Department of Agriculture.

It may be well to mention in this connection an extreme instance of injury to beans reported by Mr. J. H. Matheny, Long Beach, Miss. May 20, 1899, he sent larvæ, with the accompanying statement that they destroyed the bean crop in that vicinity nearly every year, the damage being estimated at thousands of dollars. In response to inquiry our correspondent sent additional specimens of larvæ, together with moths and bean pods, showing the work of this species, and further stated that no other insect was concerned in this injury, and that the boll worm was destroying the bean crop of the entire Gulf coast.

The Fall Webworm (*Hyphantria cunea* Dru.).—During the years 1899

and 1900 this species was frequently observed on beans, and in one instance destroyed quite a number of vines of pea. In another case a larva was observed eating into the ripe fruit of tomato September 18.

The Garden Flea-hopper (*Halticus uhleri* Giard).—Prof. F. M. Webster has stated that he obtained newly hatched nymphs in the field May 8, showing, he believes, that the species winters over in the egg, as no adults were to be found. In Entomological News for April, 1900, the same gentleman states that there are probably not less than five generations of this species at Wooster, Ohio, annually.

In May and June, 1900, this insect was observed in some numbers on beans in different localities, and some leaves were found to have been

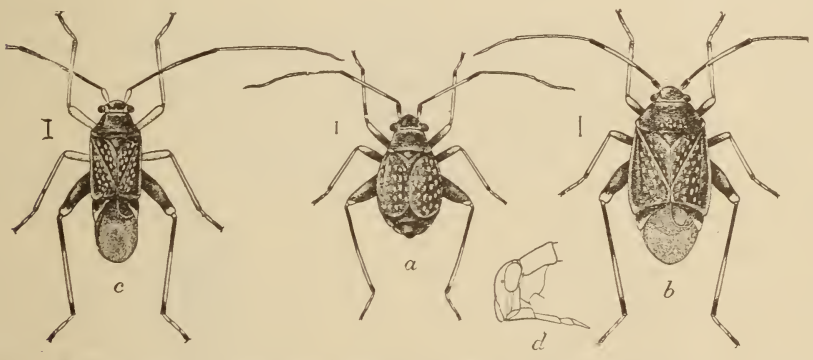


FIG. 25.—*Halticus uhleri: a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline—*a*, *b*, *c* much enlarged, *d* more enlarged (author's illustration).

killed by its attacks. Beets and cabbage were also affected, but injury was less noticeable to these crops.

In 1901 the writer noticed severe injury to ornamental morning-glory in the city of Washington.

Acanthocerus galeator Fab.—This plant-bug, better known in literature and in collections generally as *Euthoctha galeator*, has been often seen on garden beans during recent years. September 8, 1900, Mr. F. C. Pratt observed an adult with its beak sunk in the stalk of a bean plant, so there can be no doubt of this host plant, although injury has as yet not been reported.

So little is definitely known of the true food habits of this species that it may be well to mention some of the reports concerning it:

It first came under observation at this office May 27, 1879, when Mr. Theodore Pergande observed a specimen sucking the sap from the petiole of a leaf of a terminal shoot of raspberry, the result being that the petiole became black and the leaflets wilted.

July 5, 1895, Mr. D. B. Story, Darwin, Ohio, reported that this insect did much damage to nursery stock, particularly yearling apple trees, by stinging and blighting the tender tips.

June 8, 1899, Mr. Pergande observed one of these bugs sucking young shoots of plum, which were afterwards observed to wilt and turn black as in the observation made on raspberry; and during September, 1900, he obtained a number of ymphs mostly in the last stage, attacking common ragweed (*Ambrosia artemisiæfolia*), this latter being, therefore, undoubtedly a natural food plant.

An account was given of this species by the late H. G. Hubbard in "Insects affecting the orange," which includes a figure of the adult and brief description of the eggs and the young nymphs. He states (p. 163), "it is a very common and often a very destructive insect," presumably to orange in Florida.

In a recently published account of this species by Messrs. Forbes and Hart (Bul. 60, Univ. Ill. Agric. Ex. Sta., p. 445) some additional notes are given, it being stated among other things that the authors found it on blackberry and raspberry, and on forest undergrowth in Illinois. It is stated on the authority of Bruner to occur on beets and on wild cucumber.

Alydus eurinus Say and **A. pilosulus** H.-S.—During January, 1901, Mr. F. E. Brooks, French Creek, W. Va., wrote of an insect which is described as somewhat resembling the squash bug, and which he stated was injuring his Lima beans and late cowpeas.

January 15, he sent specimens found among dead bean vines, which there was no trouble in identifying as the above species. Specimens of bean pods accompanied this letter, and both pods and beans plainly showed punctures of a sucking insect, the beans being quite disfigured by the numerous discolorations formed about the punctured spots.

In continuation of observations conducted in 1901, Mr. Brooks also sent additional specimens of this species of the variety *ater* Dall., as also of *Alydus pilosulus* H.-S., with information that they appeared to be responsible for the diseased condition of cowpea. October 28, 1901, Mr. Brooks wrote that these insects occurred again in considerable numbers, but the early frost killed the vines of cowpea, as also the pods, and rendered it impossible to determine to what extent the insects were responsible for the spread of the disease in the beans and cowpeas. Our correspondent, however, was still of the opinion that under favorable conditions these insects transmitted the disease from one pod to another and that they may prove at times a serious pest. He had observed them at the date of writing collected upon the dry pods of cowpea. They thrust their beaks quite easily through the dry pods and appeared to be feeding on something within for one or two minutes, when they removed their beaks and inserted them in another place. He could not determine whether the puncture extended to the seeds within or not. Our correspondent's opinion is of value, as he was perfectly able to distinguish the two species of Alydus, notic-

ing also that copulation took place only with the insect's own kind and not with the associated species. The two species occurred in about equal numbers, their habits being the same.

Leaf-hoppers (Tettigoniidæ and Jassidæ).—Various species of leaf-hoppers of the families Tettignoiidæ and Jassidæ were under observation during the past three years on experimental plats of the Department of Agriculture on cowpea and beans. They occurred in all stages, feeding on the under surface of the leaves, but were not present in really injurious numbers.

The crafty leaf-hopper (*Diedrocephala versuta* Say) was the most conspicuous species, on account of its larger size and brighter colors, although numerically less than the smaller Empoascas, with which it

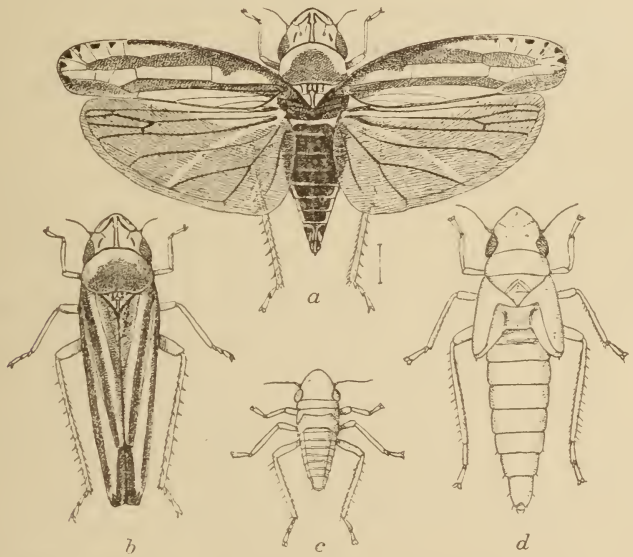


FIG. 26.—*Diedrocephala versuta: a*, male with expanded wings; *b*, same with wings folded; *c*, young nymph; *d*, last stage of nymph—all much enlarged (original).

was sometimes associated. Adults were present from June to September. This, like many other leaf-hoppers, probably lives largely on grasses, but cowpea is also greatly relished. Without doubt it agrees rather closely in habits with the better-known red-banded leaf-hopper (*Diedrocephala coccinea* Forst.), to which it is closely related. The latter, according to Messrs. Osborn and Ball, is double-brooded (Bul. 34, Iowa Agr. Coll. Exp. Sta., p. 615, 1897). From the latter, *versuta* differs chiefly in its smaller size and by having the vertex with the black markings nearly parallel with the anterior margin, which is usually black-lined. There is often a pair of approximate median lines on the disk. *D. coccinea* is reddish, with green stripes on the pronotum and elytra, while in *versuta* yellowish or greenish predominates, with occasionally reddish on the upper surface. A mature male

of this leaf-hopper is shown in figure 26 at *a*, with wings spread as in life, while at *b* the same is illustrated with wings folded in the natural position which it assumes when feeding or at rest. From the nature of its markings this is a rather attractive species, and the yellow of the common form found in the District of Columbia is variegated above with green and bluish, forming stripes on the wing-covers, as shown. A young nymph or larva is illustrated at *c*, and *d* shows the nymph in the last or pupal stage just previous to molting.

This species, as defined by Prof. E. D. Ball (Proc. Iowa Acad. Sci., Vol. VIII, 1901, p. 30; Ser. 5, No. 21, Ohio St. Univ. Bul., p. 31), is evidently more abundant in the South. Its name does not appear in any lists of New York or New Jersey species at present available, although it has been recorded from Ohio and Illinois. It extends from central Mexico and the Gulf States northward to Maryland, Virginia, and the District of Columbia, and westward as far as Illinois. What are considered varieties of this species, however, have been described from South America and the Pacific coast.

As a result of the investigations of Messrs. Osborn and Ball (l. c.), some generalizations as to the life habits of these two families of leaf-hoppers have been drawn. The species under observation in Iowa showed, as a rule, a decided limitation as to the food plant, holding to one species while in the immature stage, but feeding more indiscriminately in more mature stages, in which respect these insects resemble larger forms of Hemiptera, such as the harlequin cabbage bug and squash bugs, which subsist normally on single orders of plants. The species observed deposit eggs upon the stems under the leaf sheaths or in the leaves of the food plant. There is a wide divergence as regards life histories, some species producing one generation; the majority of the grass-feeding forms, which includes a very considerable percentage of these insects, two generations; and some having three in a season. Save in the case of hibernation in the adult stage, the life of a generation of adults does not exceed two months, while that of the individual rarely exceeds one. Males appear a week or ten days earlier than the females, and their disappearance is much earlier. There is so little overlapping of generation that one of adults disappears before the nymphs of the next have matured, so that individuals observed at any time may be referred to the generation to which they belong. The eggs for each generation are deposited within a limited time, so that a period may be defined when all eggs of a given species will have been laid, and during which measures for their destruction may be applied.

As a further result of these studies of the life economy of leaf-hoppers, it was ascertained that simply cutting the grass (and perhaps other plants affected) and leaving it in the field would prevent hatching, as in no case did eggs observed hatch from stems that had been

cut while green. The drying of the stems results in the crushing and distortion of the eggs, due to the shrinkage of the plant tissues and to the curling of the edges of the sheaths.

Stictocephala festina Say.—Another leaf-hopper, was sent in abundance to this office by Mr. Thos. I. Todd, Athens, Ga., October 2, 1899, with the accompanying statement that they were affecting Lima beans, and that they were not noticed before August of that year. Our correspondent stated that this insect caused the vines which it infested to shed their leaves, after which the stems dried, the vine finally being killed. The method of injury by suction was noticed.

The species is one of wide distribution, but little appears to have been published concerning its habits. There is at least one record of injury, however, that published in Insect Life in 1888 (p. 50), which has reference to damage to young tomato plants at Wilmington Island, Ga., in April and May, 1887. Injury is described as being due to the insect "ringing" the stem, causing the plant to wilt. The recorded distribution includes territory from Connecticut in the North and East to Florida and Texas in the South, and in the West to Colorado and Montana.

The Bean Aphis (*Aphis rumicis* Linn.)—This well-known species, which is common to this country and to Europe, having evidently been introduced from the Old World, has been noticed during the past four years in most patches or fields of bean and cowpea examined, being especially abundant upon the latter crop plant.

During 1899 and 1900 it was present on Lima bean, in sufficient numbers to attract rather general notice particularly at Marshall Hall and Cabin John, Md., and St. Elmo and Alexandria, Va. It is particularly noticeable on the last-mentioned plant from its habit of congregating on the terminal leaves and flower heads and about the stems of the pods.

The species has been the subject of considerable study by different economic writers, including Fitch, who has given it extended notice in his thirteenth report on noxious and beneficial insects of New York (1869, pp. 495–512), and Messrs. Osborn and Sirrine (Bul. No. 23, Ia. Agr. Coll. Expt. Sta., 1893, pp. 901–905). In the article last cited, which is entitled "Life history of a common plant-louse (*Aphis rumicis* L.)," a good account of the life cycle of the species is given as observed at Ames, Ia., and, as this locality is not particularly different, zoologically and geographically speaking, from the District of Columbia, no special study has been given the species by the writer.

Wireworms.—Leguminous crops do not appear to be much affected by wireworms. No doubt the insects are frequently present, but injury is seldom apparent. There is one, however, that has been identified with attack on bean. This is a common species, particularly southward, and known as *Monocrepidius vespertinus* Fab.

Numerous individuals of this click-beetle were observed by the writer during the first two weeks of July at Colonial Beach, Va. (which is about 45 miles south of Washington, D. C.), in beds of beans where no other plants grew. Search was made for the larvæ, but it was evidently not the season for them, as none were found. There can be no doubt of their infesting beans, as at this time the species in question was the most abundant of all insects observed in that field. The larva and beetle are shown in figure 27.

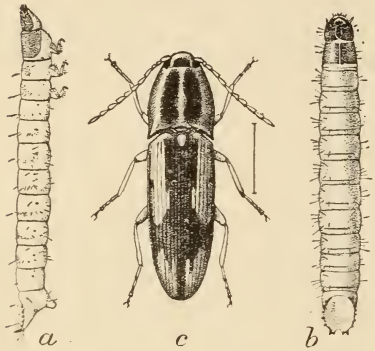


FIG. 27.—*Monocrepidius vespertinus: a*, larva, side view; *b*, larva, dorsal view; *c*, beetle—all three times natural size (original).

NOTES ON FLEA-BEETLES.

Among other injurious forms of insect life that were noticeable by their numbers during the season of 1900, flea-beetles of several species occupied an important place. Some of the injurious forms which were attached to special plants and some of the more striking instances of injury by species of omnivorous tendencies will be mentioned in connection with other observations that were made concerning them. During 1901 some species were injurious, but, as a rule, not so abundant and troublesome as in the preceding year.

The Pale-striped Flea-beetle (*Systena blanda* Mels.).—The pale-striped flea-beetle was one of the most abundant and troublesome forms during the year 1900. In the latter half of May and early June it was noticed by the writer and others in greater abundance in Maryland and Virginia near Washington than in any previous year, and was concerned in inj ury to beans in several localities. It was reported to be troublesome to the same crop at Woodside, Md., and St. Elmo, Va., by Messrs. Olds and Pratt of this Department, respectively. The latter reported that during June it did great damage to pole and bush Lima beans, while the ordinary field or garden beans were scarcely touched. In some cases replanting was necessary. The occurrence of the beetles in considerable numbers on other cultivated plants as well as upon weeds was noticed, but damage was observable only to beans in the localities mentioned. Beets were also the subject of attack, as observed by the writer, and reports of injury to beets reached us from different regions. This crop, however, was not severely injured, the beetles seeming to prefer the leaves of bean when they were obtainable to any other food crop. In other more distant localities it will be noticed that beans and peas were also much injured and beets suffered considerably in Michigan and Colorado, as reported.

June 18, 1900, we received specimens of this species together with

S. hudsonias, with report that they were injurious to pole beans, as will be mentioned more in detail in consideration of the latter species, at Milo Center, Yates County, N. Y.

Mr. Edward C. Post, Dundee, Mich., who sent specimens of this beetle in 1889 from Monroe, Mich., wrote June 21, 1900, transmitting specimens taken from four different fields of sugar beet some 5 miles apart and about 18 miles from Monroe. In two of these fields the beetles did considerable damage.

August 8, 1900, Mr. Carroll Fowler, of the Agricultural Experiment station, University of California, at Berkeley, Cal., sent specimens of this beetle with the information that they had been received from Mr. W. Winterhalter, Rockyford, Colo., where they were doing considerable damage to sugar beet. Mr. Winterhalter describes the work of this beetle as follows:

> It bores the leaves from the upper side, boring regular holes clear through the leaves, and, as it appears in swarms of millions, it practically kills the plants which are two or three weeks above the ground. These flies have destroyed quite a few acres in our Pueblo district. They are doing likewise with cockleburs, sand burs, and other weeds. The beets are badly injured and their growth is checked considerably, but this fly is too small to destroy old plants completely. The specimens were collected June 19, 1900.

During the summer of 1899 imagos were reared July 22 and 23. In 1900 imagos of the new generation were observed August 25, over a month later.

May 18, 1901, Mr. W. J. Langston, Sixmile, Ala., sent specimens of beetles and cotton leaves, the latter showing severe injury by this insect. The beetles had been seen at work only two days.

May 21, Mr. B. M. Moose, also sent specimens with leaves of cotton showing similar injury. He stated that the beetles were very numerous on his farm at Simpsonville, S. C., having made their appearance two days earlier. Beets were also injured.

June 20, Mr. A. L. Beals, Deming, Ind., sent numerous specimens of this beetle with report that, although the species had been in his garden only about three days, it had done great damage, especially to radish, beet, bean, melon, and cucumber.

The Red-headed Flea-beetle (*Systena frontalis* Fab.).—One of the injurious occurrences of the year 1899 was that of the so-called red-headed flea-beetle, *Systena frontalis* Fab., at Syracuse, N. Y., reported by Smiths & Powell Company, August 3, as injurious to sugar beet. Although this is the only case of damage reported from there during that year, it is possible that there was an outbreak of the species in that portion of the United States and perhaps Canada, as this insect is known to be periodically troublesome in that latitude.

Systena frontalis was first reported by Mr. William Saunders as injurious in the year 1882 (Can. Ent., Vol. XIV, p. 147; 13th Rept.

Ent. Soc. Ont. for 1882 [1883], p. 10), having been noticed at Oakville, Ontario, Canada, where it was damaging the leaves of grape. The beetles were described as being very abundant and destructive, eating the green tissue of leaves on the upper side, causing them to wither.

After a lapse of five years this species was observed, together with *S. blanda*, attacking potato at Wea, Ind. (Webster, Rept. Dept. Agr., 1887, p. 151), and was again troublesome in Canada, this time as a pest in the shrubbery and on the seed beds of the botanical garden of the experimental farm at Ottawa (reported by Dr. James Fletcher, in his report as entomologist and botanist of the Dominion of Canada for 1889 [1890], pp. 87, 88). Young plants and low shrubs of a great many botanical orders were attacked, ravages being particularly noticeable upon some species of Althæa, Hibiscus, and Weigelia, as also upon young grape vines. Injury was all done by the perfect beetles, few plants appearing to come amiss to them.

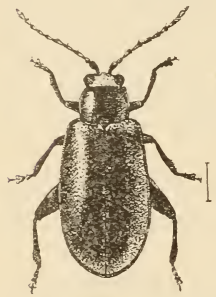


FIG. 28.—*Systena frontalis*—much enlarged (original).

In 1891 we received specimens, August 11, from Smiths & Powell Company, Syracuse, N. Y., with the information that the beetles were doing damage to pear by eating the soft leaves. A remedy was requested, as it was feared that, if the beetles were left undisturbed, that they would become a nuisance (Insect Life, Vol. IV, p. 135).

The same year we reported this insect as feeding upon beet leaves at Lincoln, Nebr., and on the leaves of *Hibiscus militaris* at Westpoint, Nebr., at which places the insect was observed by Mr. Lawrence Bruner in 1890 (Bul. 23 [old series], Div. Ent., 1891, p. 15).

The writer has been familiar with this species for a great many years, having first observed it at Ithaca, N. Y., in company with the commoner but less troublesome *Systena hudsonias*, on smartweed, pigweed (*Chenopodium album*), and other weeds in August and September (Proc. Ent. Soc. Wash., Vol. II, p. 266).

In the late Dr. Lintner's report as State entomologist of New York for 1892 (p. 343), he records the occurrence of this Chrysomelid in injurious numbers on the foliage of gooseberry at Geneva, N. Y., during the latter part of July and early August of that year.

In 1893 this flea-beetle was again troublesome in Canada, and was mentioned by Dr. Fletcher in his report for that year (1894, p. 28). It attacked a great variety of plants, including potato, horse bean, many kinds of deciduous shrubs, and young grapevines, having been especially injurious to grape at Ottawa. Its attacks were worse on those varieties which belonged to the thin-leaved grapes derived from *Vitis riparia*, the greatest damage having been done to young seedlings which were not trained on trellises and which had not been sprayed with fungicides.

In 1896 Mr. W. S. Blatchley mentioned this flea-beetle in connection with its occurrence at Indianapolis, Ind., stating that it occurred commonly in June on the leaves of the great ragweed, *Ambrosia trifida*, and that it had once been taken under bark in February (Psyche, Vol. VII, p. 437).

In 1900 Messrs. Forbes and Hart (Bul. 60, Univ. Ill. Agr. Exp. Station, 1900, p. 468) made brief mention of this species as an enemy of the sugar beet, introducing an original illustration of the adult.

The red-headed flea-beetle, as its scientific name shows, is congeneric with the pale-striped flea-beetle (*Systena blanda*), which has been treated in preceding pages and more in detail in an article by the writer in Bulletin No. 23 of the present series (pp. 22–29). It is of very similar form, a little more elongate and considerably larger, and differs, moreover, in being shining black throughout, except for the greater portion of the head, which is red. It is not likely to be confused with any other flea-beetle, and is nearest related to *Systena hudsonias*, which is entirely black and a little smaller. Apart from the color of the head, *frontalis* may also be distinguished from *hudsonias* by its somewhat broader form, the elytral punctation being less coarse, but rather more dense. It is shown five times enlarged at figure 28. The immature stages seem not to have been recognized.

The habitat of this species has been outlined by Mr. H. F. Wickham so as to include the entire region east of the Rocky Mountains (Proc. Davenport Acad. Nat. Sci., 1896, p. 162). From a statement made by Dr. Horn concerning it (Trans. Amer. Ent. Soc., Vol. XVI, 1889, p. 270), it might be inferred that its range extends from the Canadian region to the Southern States. Judging from reports of injury this species may be said to be a Transition form, extending southward through the Upper into the Lower Austral region. The list of localities in which it is known to occur includes: Vermont; Springfield, Mass.; Buffalo, Ithaca, Syracuse, Geneva, and New York, N. Y.; New Jersey, generally distributed (Smith); Iowa City, Iowa; Michigan; Westpoint and Lincoln, Nebr.; Columbus, Tex. (June 16); Florida; Ottawa and Oakville, Ontario, Canada.

The Smartweed Flea-beetle (*Systena hudsonias* Forst.).—July 26, 1899, Mr. George G. Atwood, Geneva, N. Y., transmitted specimens of this flea-beetle with the report that it was destructive to sugar beet in that vicinity. There is an earlier unpublished Divisional record of attack made to this office May 23, 1896, by Mr. B. F. Ferris, Sunman, Ind., who sent beetles with *S. blanda*, and the report that they were injuring corn in his neighborhood. It is only in recent years that this species has attracted any attention as a pest, the first record of injury known to the writer having been published in 1887 (Report Dept. Agr., 1887, p. 151). In that year Mr. F. M. Webster observed damage by this insect to potato at Wea, Ind., attack being shared, as in the

preceding case, with *S. blanda*. August 17 1892, we received from Mr. Geo. Lamoreux, North Hector, N. Y., specimens of this beetle, with the statement that it fed on the leaves of grape and was noticed also on potato tops and on Canada thistle. June 18, 1900, we again received specimens of beetles together with *S. blanda*, with report that they were injurious to several acres of white pole beans at Milo Center, N. Y. Our correspondent, Mr. A. H. Ansley, stated that nearly one-fourth of the plants above ground at the time of writing were riddled by the insects. Attack was first noticed June 16, when only an occasional plant was being eaten, but at the date of writing many more of the beetles were seen, and the first plants infested were dried and crisp except a young center leaf just budding out. Sweet corn and other plants in the vicinity appeared to be exempt from attack.

This flea-beetle is shining black throughout and may be distinguished from *frontalis*, to which it is nearly allied, by the characters given in the consideration of that species (fig. 28).

According to Horn, the distribution of *S. frontalis* in the United States extends "over the entire region east of the Rocky Mountains."

Early in the past decade the writer had occasion to observe this flea-beetle in great numbers at work on a variety of weeds growing in the vicinity of the District of Columbia. From an account published in the Proceedings of the Entomological Society of Washington in June, 1892 (Vol. II, p. 266), the following list of observed food plants of the beetles with other notes is taken:

Smartweed (*Polygonum hydropiper*), dock (*Rumex* spp.), daisy (*Chrysanthemum leucanthemum*), fleabane (*Erigeron canadensis* and *philadelphicus*), plantain (*Plantago major* and *lanceolata*), ragweed (*Ambrosia artemisiæfolia* and *trifida*), golden rod (*Solidago* spp.), catnip (*Nepeta cataria*), *Brunella vulgaris*, and species of vervain (*Verbena* spp.). When found upon the smartweed the little insects had riddled the leaves with holes. On dock they were also numerous. They choose by preference the tenderest leaves of young plants, those of only a few days' growth being frequently attacked, but they infest as well plants that are more mature. Their work varies according to the plant attacked, but in general they eat out little holes here and there after the manner of other flea-beetles. On warm days they are quite active and voracious. The beetles abound throughout the summer months and occur on a number of other weeds, particularly of the Compositæ, besides those mentioned.

This species is given brief consideration by Messrs. Forbes and Hart (Bul. 60, Univ. Ill. Agr. Exp. Sta., 1900, p. 467), reference to its occurrence on sugar beet at Urbana, Ill., and in New York being noted. An original illustration of the adult is also furnished. The name of smartweed flea-beetle has been proposed, and this name has been adopted in the present article.

The Toothed Flea-beetle (*Chætocnema denticulata* Ill.).—This insect occurred in unusual numbers in 1900, making its first appearance during the first week of April on grasses. May 14 the writer's attention was called to the work of the beetles on sweet corn near Cabin

John, Md., and a visit to the infested garden showed that the plants, which were only from an inch to 2 or 3 inches in height, were very badly infested. A dozen or more beetles were often found on a single plant, many *in copula*, and sometimes so many would be crowded into a single rolled blade as to make the interior look black. This was the third planting of corn which had been made in this plat.

It was not possible to make a second visit to this garden until about a month later, and then the beetles had practically disappeared. Little additional injury had been done, and it seems probable that the beetles left the plants within a week after their first being noticed.

Search was made for the larvæ at the roots of corn and grasses, but without success.

Earlier mention of this species and its attack upon millet and allied grasses was made by the writer in Bulletins 9 (n. s., p. 22) and 17 (p. 85).

It has also been mentioned by different writers as an enemy to corn and to beets. On the former plant it sometimes occurs in abundance, and does conspicuous injury by making minute holes or elongate slits and white streaks on the leaves. It has been found injuring beets to some noticeable extent in Nebraska and Illinois, and in the latter State, according to Forbes and Hart (Bul. 60, Univ. Ill. Agr. Exp. Sta., 1900, p. 466), it has been noticed in abundance on coarse grasses near Elizabeth, Ill. Like most of the Chrysomelidæ, it hibernates as an adult, and eggs have been obtained early in July. Otherwise its life history appears to be unknown.



FIG. 29.—*Chætocnema pulicaria:* beetle—for size see line at right (original).

This flea-beetle resembles the species which will next be figured, and with which it is congeneric in general structure as well as in habits. It is, however, much larger, measuring fully twice as long, or about one-tenth of an inch, is more robust, somewhat irregularly oval, and the entire surface is uniformly brightly bronzed and slightly brassy.

It is broadly distributed from the New England States southward to Florida and Texas and westward to California. It apparently occurs nearly everywhere east of the Rocky Mountains, and westward has also been recorded from Utah and Montana.

The Brassy Flea-beetle (*Chætocnema pulicaria* Mels.).—Injury to sweet corn by the toothed flea-beetle, as above reported, was complicated by the presence of this second species, which, however, occurred in much smaller numbers.

This species (fig. 29) is the more abundant of the two in most localities, and considerably smaller. It is probable that it is usually the cause of the trouble attributed to it. This flea-beetle measures less than one-twentieth of an inch, and is of oval, slightly oblong, convex

form, with shining surface, having a faint greenish-bronze luster. The legs are usually brownish testaceous, but somewhat variable. The thorax is nearly opaque, *i. e.*, it bears little trace of polish.

It is known to occur in Pennsylvania, Maryland, Virginia, District of Columbia, North Carolina, Texas, and Colorado.

The Spinach Flea-beetle (*Disonycha xanthomelæna* Dalm.).—This species occurred in greater abundance during the spring of 1900 than in previous years when it was under observation, and was found during the latter days of May and the first part of June to have attacked and practically destroyed, while in the larval condition, whole rows of beets. The beets in one instance were not otherwise in condition, but other cause of injury was not observable. This appears to be the first instance of observed injury by this insect in the East. Observations subsequently made showed that beets were generally affected in this vicinity by this insect, injury being due both to adults and larvæ. A new genus of food plants was observed during the year, as also a new insect enemy of this flea-beetle.

It was noticed of the full-grown larvæ that had fed upon beets that all were of a brilliant purple hue never before seen in this species in its occurrence on its wild (green) food plants.

Upon the occasion of a visit to Brookland, D. C., June 13, very noticeable injury was observed to beets, particularly on the edges of fields near weeds. Many plants, it was obvious at this time, would produce no taproots, and examination of numbers of them showed that this portion of the plant was entirely undeveloped. The owner of one of these gardens, Mr. E. Heitmuller, was informed of the injury and he stated to the writer that he was quite familiar with the insect and its work, and said that at least an acre of seed beets had been totally destroyed for him the previous year. He also stated that the pests went below the surface of the ground and attacked the roots. Upon digging about the infested plants larvæ and beetles were found, as well as upon the foliage, and this in spite of the fact that the day was very dark, the sun not having been visible for about two hours. There seems to be no doubt whatever that our informant is correct in his conclusions. Both larvæ and beetles, at times if not habitually, conceal themselves in the earth about the plants. It has already been shown that the larvæ travel very slowly, and hence after devouring the leaves of one bunch of plants they attack the roots instead of migrating to other plants, a feat which they are nearly incapable of performing.

In instances of insect attack to beets which have come under notice, this species has been associated with the twelve-spotted cucumber beetle, *Diabrotica 12-punctata*, and the pale-striped flea-beetle, *Systena blanda*, both of which feed more freely exposed than the Disonycha larvæ and beetles, and would attract attention when the others would

be apt to be missed. The cucumber beetle mentioned cuts holes of the same character in the leaves, and can be seen in broad daylight feeding on the upper surface. The pale-striped flea-beetle also feeds freely on the upper surface, while the beetles of Disonycha are generally found under the plants on the ground during the heat of the day and usually drop off the plants at the first sign of disturbance. At other times, the larvæ on the under surface of the leaves would not be noticed by the average observer. It will thus readily be seen that the year 1900 was not necessarily an exceptional one as regards attack by this flea-beetle in the East, as much of the injury that has been attributed to other species mentioned may often in reality be due, at least partially, to the spinach flea-beetle.



FIG. 30.—*Epitrix fuscula*, greatly enlarged (original).

August 16, 1900, the writer observed numerous beetles of this species, dead and living, under plants of saltbush belonging to different species of Atriplex, growing on the experimental plats on the Department grounds. Under these plants the ground was fairly strewn with living and dead beetles, and larvæ were found, though somewhat sparingly at this time, on the foliage. The species of Atriplex upon which this flea-beetle was observed include *A. semibaccatum*, *A. holocarpa*, *A. velutinella*, and an undetermined form—all cultivated varieties, and useful as forage plants.

Numerous nymphs of the wheel bug (*Prionidus cristatus*) were observed during the early part of June on beets infested with this flea-beetle. Such as were seen feeding had the larvæ of the beetle impaled on their beaks.

The Eggplant Flea-beetle (*Epitrix fuscula* Cr.).—Injury by this flea-beetle (fig. 30) which has been treated somewhat fully in Bulletin 19, n. s. (pp. 87–89), was very serious to early potatoes near Cabin John, Md., in 1900. When the infested fields were visited May 14, every plant was seen to be covered with the beetles. They were described to the writer as having burrowed beneath the surface of the earth in search of the potato sprouts.

The common cucumber flea-beetle, *Epitrix cucumeris*, occurred upon the same plants in less numbers, as did also the Colorado potato beetle, *Doryphora 10-lineata*. Injury was also due in part to cutworms, and to extreme heat and drought, which had lasted for several days.

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